PUBLISHED EVERY SATURDAY BY
THE W. J. JOHNSTON COMPANY, Limited.
41 PARK ROW (TIMES BUILDING), NEW YORK.
Established 1874. Incorporated 1889.
Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 62 Atlantic Ave., Boston.
Western Office, 465 The Rookery, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.
(Including Postage in the U. S., Canada or Mexico.)

In requesting your address changed, give **old** *as well as new address*

ESTABLISHED 19 YEARS AGO, THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America, and has well maintained its lead. It has the LARGEST CIRCULATION of any electrical periodical in the world, and is the BEST ADVERTISING MEDIUM.

In the growth of THE ELECTRICAL WORLD, in circulation, size and general improvement, the **value of its columns for reaching those engaged in electrical pursuits** has not failed to be **appreciated by advertisers.**

The following table shows **the steady onward march** of the paper in this department of its business, notwithstanding the numerous recent consolidations among electrical companies:

The first issue of				1888 cont'ined	175	different	adv'ts.
1881 contained	28	different	adv'ts.	1889 "	234	"	"
1882 "	45	"	"	1890 "	289	"	"
1883 "	63	"	"	1891 "	325	"	"
1884 "	82	"	"	1892 "	316	"	"
1885 "	100	"	"	1893 "	317	"	"
1886 "	138	"	"				
1887 "	154	"	"				

No announcements of the Publisher are included in this list.

"WANT" AND "FOR SALE" ADVERTISEMENTS are a special feature of **THE ELECTRICAL WORLD.** Position Wanted small advertisements cost but $1 an insertion; Help Wanted and For Sale small advertisements cost but $1.50 an insertion. Remit in advance for the number of insertions desired.

THE ELECTRICAL WORLD'S Advertising Rates are much lower than those of any other similar publication, circulation and standing considered, and vary according to space, position and number of insertions. Quotations promptly furnished.

Correspondence, views and opinions on all topics within the province of this journal are cordially invited from any part of the world. We will thank readers to forward to us—**promptly** as they occur—**Items of News,** or information relating to any application of Electricity also marked copies of their local papers containing anything likely to interest electricians. Anonymous communications cannot be noticed, nor can rejected manuscript be returned unless accompanied by the necessary postage when received.

Address and make drafts, orders, etc., payable to

THE ELECTRICAL WORLD,
41 Park Row, New York,
OR ANY OF THE BRANCH OFFICES.

VOL. XXI. NEW YORK, APRIL 29, 1893. NO. 17.

CONTENTS.

EDITORIAL: PAGE.
Paragraphs ... 311
ILLUSTRATED ARTICLES:
J. H. Rhotehamel, President of the Columbia Incandescent Lamp Company ... 313
The Story of the Evolution of the Edison Incandescent Lamp.—II ... 315
Electricity at the World's Fair ... 316
Capacity and Self-Induction in High Potential Circuits, by C. P. Steinmetz ... 318
The Electrical World's Digest of Current Technical Electrical Literature, by Carl Hering ... 320
Nikola Tesla and His Wonderful Discoveries ... 323
The New Stanley-Kelly Two-Phase Motor ... 325
An Adjustable Pole Bracket ... 327
The Milwaukee Commutator Brush ... 327
P. & S. Combination Fixture Cut-Out and Outlet Insulator ... 327
The I. X. L. Cluster Ball ... 327
A Handy Pocket Tool ... 327
Gem Blowpipe Torch ... 327
Bliss Press with Automatic Feed ... 327
MISCELLANEOUS:
Decision of the Columbia Incandescent Lamp Suit ... 312
Effect of the Incandescent Lamp Decision ... 312
Praise for the St. Louis Lamp Report ... 313
Single Phase Alternating Current Motors, by Elihu Thomson ... 314
Theodore Puskas ... 314
Explosion of a Storage Battery ... 314
A New Lamp Defense ... 314
Electrical Insurance Risks ... 314
Armour Institute ... 317
Moonlight Table for May, 1893 ... 317
Safety Fuses vs. Magnetic Cut-Outs in Electric Railway Work ... 319
New Books ... 322
The Waddell-Entz Storage Battery Cars ... 326
Candle Power of the Arc Light ... 326
FINANCIAL INTELLIGENCE: New Incorporations, 328.
SPECIAL CORRESPONDENCE: New York Notes, 328; New England Notes, 328; Western Notes, 328; English Notes, 328.
NEWS OF THE WEEK: The Electric Light, 328; The Electric Railway, 328; Personal Notes, 329; Miscellaneous Notes, 329.
INDUSTRIAL AND TRADE NOTES ... 329
BUSINESS NOTICES ... 330
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 330

Storage Battery Traction. IN the near future an exhaustive test of the Waddell-Entz storage battery street railway system will be made under the most favorable auspices, and the result will go a long way toward definitely settling one way or the other the question of storage battery traction. A complete and admirably designed plant for handling and charging the batteries has been installed in commodious quarters, and a section of the Second Avenue street railway will be exclusively served by specially designed storage battery cars, of which ten are to be used. All of the details seem to have been considered with unusual care from an engineering and mechanical standpoint, and no doubt the same competent supervision will be given to the details of the trial. As the financial backing is ample, and the cordial co-operation of the street railway authorities assured, the test will be one of more than usual value. No previous trial perhaps has been conducted under conditions so favorable; as a rule, they have heretofore either been so partial in their extent or made in such a hap-hazard or crude manner that their results have been entitled to little weight.

Tesla and His Work. ELSEWHERE in to day,s issue will be found a highly interesting interview with Mr Nikola Tesla taken from one of our enterprising daily contemporaries. Mr. Tesla, in his own graceful way, tells the story of his life and the history of some of his more important inventions. Perhaps there is no living scientist in whose life and work the general public takes a deeper interest, especially in this country. One of the evidences of his popularity is the wide circulation of THE ELECTRICAL WORLD Daily Bulletin on the evening of his lecture at the recent convention at St. Louis, to which reference is made in the opening paragraphs of the *Herald* article.

The Effect of the Decision THE full effect of Judge Hallett's decision in the Columbia case can hardly be appreciated at this early stage. The uncertainty which has existed throughout the electrical field has at least been relieved, and the knowledge of the fact that incandescent lamps can be obtained from other sources than the General Electric Company cannot but have a stimulating effect upon the electrical business generally. It seems to be the general belief that the so-called monopoly of the General Electric Company has been broken, and the opinions of a number of those well qualified to speak upon this subject will be found elsewhere in this issue. The ultimate result of the patent litigation is, of course, not determined by this decision; but the relief so much needed will be welcomed by those identified with electrical enterprises of any character and not interested as participants in the lamp litigation. As voluminous testimony will now have to be taken, and witnesses appear to be examined and cross-examined, which is always a great thief of time, no final decision can be looked for until after the Edison patent shall have expired. Thus so far as users of incandescent lamps are concerned the relief may perhaps be considered permanent.

A Tardy Awakening. PROBABLY no decision involving electrical interests has created more surprise than that in the case of the Edison Electric Light Company vs. the Columbia Incandescent Lamp Company. We give Judge Hallett's opinion in full in another column. Many had been led to suppose that Judge Colt's decision in the Beacon case had practically killed the Goebel defence, and the Columbia case was, therefore, almost entirely lost sight of. There was no report of the proceedings either in the daily or the electrical press, except that in THE ELECTRICAL WORLD, which had the semblance of truth or accuracy to recommend it. One of our contemporaries, which lives nearest the scene of battle, but was content to evolve from its inner consciousness an admirably worded though erroneous report, and which lent the weight of its judicial opinion that there was nothing in the case, has, we learn, awakened to the fact that it had been fast asleep, for it came out on Saturday afternoon with a supplement containing Judge Hallett's opinion, which it had culled from the columns of the St. Louis evening papers of the day before. This shows commendable enterprise, and we congratulate its editors upon their acumen and foresight. We presume other of our contemporaries will indorse in like manner the position assumed in our last issue by publishing in full the opinion in a case which last week they regarded as of no consequence whatever.

Alternating Current Motors. NOTWITHSTANDING the rapid expansion in the use of the alternating current it has been laboring under a serious disadvantage through the lack of a motor as general in its application as that employed by its continuous current rival. As the field of such a motor is almost unlimited there has naturally been much study devoted to the subject and several types more or less promising have been evolved. Many difficulties, however, have been encountered in the production of a motor which would fulfill the necessary practical requirements of being self starting, not heating unduly and capable of being used on the same circuit with incandescent lamps and with the high frequencies generally employed in this country, and at the same time not load up the line and generator with false currents. For the special transmission of large powers the reversed alternator answers passably well, but owing to its having to be brought into synchronism by a separate apparatus, its general employment on commercial lighting currents is, of course, impracticable. Notwithstanding the great promise of the three-phase motor it has come into little or no use in America, and the same is true of several other types, principally of foreign design, that have been widely heralded, one of the obstacles undoubtedly being the high frequencies adopted in this country. While the past has thus accomplished little in this line from a practical standpoint the prospects for the future are more hopeful owing to the number of able minds now working on the subject, and we publish in this issue a description of a two-phase motor system, designed by Messrs. Stanley and Kelly, that promises in itself a comprehensive solution of the problem and which, we predict, will excite a most lively interest, both at home and abroad. The successful practical test to which the system has already been subjected in actual commercial use renders its serious consideration more certain, particularly in view of the contrast in this respect with other systems that too often are brought before the public only to demonstrate that they are yet in the laboratory stage. The Stanley-Kelly motor contains the important features of being self-starting with full load torque, and capable of being used on lighting circuits of high frequencies. The third wire required is fully compensated for by the saving in copper over the two-wire single-phase system, and the transformers are of the ordinary type and involve no complication. The compensating system is an ingenious conception that disposes in an exceedingly simple and effective manner of the serious question of armature reactions. The condenser, on the other hand, introduces an element of uncertainty and one whose commercial application to similar purposes has heretofore been regarded with disfavor; the inventors claim, however, that by their method of manufacture and with the materials used they are able to produce a perfectly practicable condenser, as has been abundantly demonstrated to them by long continued tests and by actual commercial use. Aside from this the system seems to embrace no doubtful features and its introduction to the public marks a red letter day in the history of the alternating current, and one from which we hope a new era in electric lighting and power may be dated.

Judge Hallett's Decision. IT will be noticed that Judge Hallett, in his decision, covers several points very clearly that have a wider bearing than this particular case would seem to imply. In answer to the complainant's objection to the Goebel claims that this lamp could not have been made by any single individual at the time claimed, and that because the Edison lamp in its development had involved several auxiliary arts or sciences, all other lamps of similar character must have necessarily passed through the same course of evolution, Judge Hallett said that "this is no more than to say that no man can outrun his competitors to any great extent in the field of scientific investigation—a proposition which has no support in reason or experience." That the methods adopted by Goebel to reach his results, or that his results, when obtained, were not equal to those of Edison, Judge Hallett says has no bearing on the case, provided only that those results were of a practical nature and similar. That those results were practical and similar he regards as proved by a fair preponderance of testimony which, in his opinion, is sufficient in this case, for he says: "It is not reasonable to demand such certainty as to the defense," for such certainty as is claimed by the plaintiffs as necessary is not often attained upon testimony in the form of affidavits. He throws the responsibility upon the plaintiffs, for he says: "Complainants must show a clear right in support of a preliminary writ, and a defense which puts the case in doubt is sufficient to defeat the application." Thus far Judge Hallett holds diametrically opposite views from Judge Colt, who, it will be remembered, said: "It is simply impossible under the circumstances to believe that a lamp so constructed could have been made by Goebel before 1872." As regards this, Judge Colt further says: "Nothing in the evidence warrants such a supposition, and other things show it to be untrue." Here we have evidence of the effect which the *new* testimony had upon the case, for it would seem that the latter must, in Judge Hallett's opinion, have cleared up those other things which its absence had seemed to prove untrue. One of the chief things which was suspicious in the Beacon case was the genuineness of the Goebel lamp No. 4. This s made clear by Judge Colt, who stated that this exhibit threw a mist of suspicion upon the whole of Goebel's testimony. How fully the defense covered this weak point was clearly shown in THE ELECTRICAL WORLD in its last issue. In regard to who should bear the burden of proof the two opinions are really less at variance than would at first appear. Judge Colt held that a meritorious invention could not be defeated by something which rested upon speculation or experiment, and that the presumption of novelty arising from the grant of the patent was not to be overcome except upon the most clear and convincing proof. Judge Hallett does not deny this, but, as has been seen, holds that it is not reasonable to demand such a certainty where by the nature of the evidence (affidavits) such certainty cannot be reasonably expected. He holds that under the conditions before him such certainty should be only required where it could reasonably be expected to be proved, viz., at a final hearing where the witnesses could appear in person and be submitted to cross-examination. The judge clearly ruled in favor of the claim made by the defendant that this defense was new, for, as he says, "although respondent was not a party to that litigation (the New York case) the court would not, on a preliminary motion, consider any matter which passed to judgment in that suit." As regards the Beacon case, he does not admit that the present case is the same in all its aspects, but assuming that it is he sees no reason why when one court has decided another court of equal jurisdiction should become a mere echo of the first. He says that in the present case he has much additional testimony to that upon which the court acted in Boston, and that he does not feel compelled to accept the decision of the court in that case upon all points. He does, however, feel sufficiently influenced by Judge Colt's decision to require from the defendant an indemnity bond of $20,000.

Decision in the Columbia Incandescent Lamp Suit.

The decision of Judge Hallett on the motion for preliminary injunction on behalf of the Edison Electric Light Company et al. vs. The Columbia Incandescent Lamp Company, in the United States Circuit Court for the Eastern District of Missouri, was looked forward to with great interest, not only by those directly connected with the incandescent lamp industry, but by the electrical public generally. The case at first attracted but little attention. The Electrical World, however, early saw its importance and was the only electrical journal represented at the trial. The result has justified the very complete report of the case which appeared in these columns last week.

The arguments of the counsel on either side were very fully given in the last issue of The Electrical World. The defense was in brief "non-infringement," supported by a large number of new affidavits and the exhibition of a number of the Goebel lamps and tools not introduced in the somewhat similar suit in the East. The plaintiffs maintained that the question of infringement had been already definitely settled in the courts; they denied the genuineness of the exhibits, and claimed that no testimony had been introduced which touched upon points not already adjudicated.

The case was ably argued on both sides, and the greatest interest was manifested in the attitude of the court toward the evidence introduced and the probable tenor of the judge's opinion.

Judge Hallett at the close of the case intimated that he would hand down his decision within a week if possible, and on Friday, April 21, just seven days later, it was received. The injunction was refused and the full text of the opinion accompanying it is as follows:

TEXT OF THE OPINION.

Complainants allege infringement of letters patent No. 223,898, issued to Thomas A. Edison, Jan. 27, 1880, for an improved electric lamp. This patent came under the consideration of the Circuit Court of the Southern District of New York, in the case of Edison Electric Light Company vs. U. S. Electric Lighting Company (47 Fed. Rep. 454), and was held to be for a lamp "consisting essentially of a filamentary carbon burner, hermetically sealed in a glass vacuum chamber." So understood it is the incandescent lamp in common use, and no question is presented in this record as to the character of respondents' manufacture. The defense to the bill and to the motion for preliminary injunction now under consideration is want of novelty in the Edison patent. Respondents aver that an incandescent lamp different in form, but in all essential features the same as that now in general use, was made as early as 1854 by Henry Goebel, of New York City, and that it was used by him in various ways and at different times for many years thereafter. It will not be necessary to describe this lamp at length, as it has the same constituents as the Edison lamp. We are at present more concerned with the struggle between the contending forces, on the one side to maintain, and on the other to disprove, the existence and use of the lamp anterior to the date of the Edison invention. A large mass of testimony in the form of affidavits is offered by each party on the question of fact, which, to consider at length, would be a tiresome and unprofitable task.

The principal objection urged by complainants against the Goebel invention is that it has an impossible date; no man could make it in the time and manner assigned to it; the incandescent lamp is the product of several auxiliary arts not likely to fall within the compass of a single mind; as an achievement of science the lamp is a matter of progressive steps, some of which must be made by the world at large, before others can be taken by any one. This is no more than to say that no man can outrun his competitors to any great length in the field of scientific investigation—a proposition which has no support in reason or experience. There seems to be no reason for saying that Goebel could not reach in 1854 the point attained by Edison in 1879, unless as was said by the dissenting justices in the telephone cases: "It is regarded as incredible that so great a discovery should have been made by the plain mechanic, and not by an eminent scientist and inventor."

In so far, however, as it may be shown that the methods adopted by Goebel were not equal to the results obtained, the evidence should receive the most careful consideration. On this point it appears that Goebel has recently made several lamps of the form and with the material and tools formerly used by him. These lamps were tested by men of skill and experience in such matters and they were found to be reasonably effective. They are not so good as the lamps in common use, but they can be operated, and they give reasonable service in time and capacity of light. So that in this way we have prima facie proof of Goebel's ability to make lamps in the way he claims to have made them before the time of Edison's invention.

It is said that Goebel is involved in contradictions and misstatements of fact due to the lapsing memory of old age or to untruthfulness. Be it so, he does not appear to be an adventurer or an impostor. It is not reasonable to believe that he made the story related in his affidavit and did not make the lamp he has described. Whatever may be said as to Goebel's veracity he is supported at many points by witnesses of good repute who speak with precision and apparently with deliberation. As already suggested it is not necessary or profitable to go over the testimony at length with a view to determine the relative value and weight of every part. It is enough to say that there is a fair preponderance of testimony in support of the Goebel claim.

There is not the measure of proof demanded by complainants' counsel, who maintain that the court should require proof of the fact beyond reasonable doubt. This degree of certainty is not often attained upon testimony in the form of affidavits where the issue is contested. And it is not reasonable to demand such certainty as to the defense. Complainants must show a clear right in support of a preliminary writ, and a defense which puts the case in doubt is sufficient to defeat the application. (Goodyear Co. vs. Dunbar, 1 Fisher, 472. Glaenzer et al. vs. Wiedered et al., 33 Fed. Rep. 583. Fraim vs. Sharon Valley Malleable & Gray Iron Co., 27 Fed. Rep. 457. Cary vs. Domestic Spring Bed. Co., 26 Fed. Rep. 38. Robinson on Patents, Sec. 1171.)

It is also contended that the decree of the Circuit Court of New York against the United States Electric Lighting Company, sustaining the patent, which decree has been affirmed in the Court of Appeals of the Second Circuit, is conclusive of complainants' right to the writ for which they now ask. No doubt is entertained as to the conclusive effect of that decree here and elsewhere as to all matters in issue in that cause. For although respondents were not a party to that litigation, the court would not on a preliminary motion consider any matter which passed to judgment in that suit. But the Goebel defense was not made in that suit, and therefore the case has not the authority on this motion which has been ascribed to it. (National Hat Pouncing Machine Co. vs. Hedden et al., 29 Fed. Rep. 147. Lockwood vs. Faber, 27 Fed. Rep. 63. The Bailey Wringing Machine Co. vs. F. F. Adams et al., 3d B. & A. 96.)

Another suit by the complainants against the Beacon Vacuum Pump and Electrical Company in the Circuit Court for the District of Massachusetts is in a different attitude. In that suit the Goebel defense was made, and upon motion for preliminary injunction recently heard and allowed, it was overruled. It is contended that the ruling in that case should be recognized and followed as a precedent in respect to the present motion. And perhaps, if the issue, the testimony and the situation of the parties appeared to be the same in both cases, such result might follow; more from the persuasive effect of the opinion of another court on the same matter than from any notion of authority ascribed to such opinion. In courts of equal jurisdiction proceeding concurrently in the investigation of the same subject the right and duty of each to exercise independent judgment cannot be denied. That they should in the end reach the same result is greatly to be desired, but one cannot become an echo to the other for that praiseworthy purpose. In this instance the consequences to flow from diverse opinions are not regarded as serious. In the Massachusetts Circuit, and here as well, the motion is interlocutory; and in each case the ruling may well enough stand upon the situation of the parties. And we have much additional testimony to that upon which the court acted in the Beacon case; so that upon all points I do not feel compelled to accept the opinion of the court in that case.

The ruling of the court, however, in the Beacon case suggests the propriety of taking security from respondent for observing the decree in case complainants shall ultimately prevail in this suit. There are other considerations also which should have weight in that direction. It was suggested by complainants' counsel that respondent is a concern of small capital; and that it was made so with intent to avoid responsibility in respect to the infringement now alleged against it. This was not denied, and I suppose we may take it to be true. The retort was in the form of a charge against complainant that it used its monopoly of electric lamps to control the sale of all kinds of electric machinery and apparatus. This charge also passed without denial, and it is not difficult to conceive of circumstances in which it would be necessary to ascertain whether it is true. Referring only to the charge against respondent of insufficient capital and assets the duty of the court is plain to provide for the contingency of a decision against it. I need not refer to the possible effect of cross-examination in the case of a multitude of witnesses. What now seems plain enough may altogether disappear and new facts may come to the surface under that crucial test.

The injunction will, therefore, be refused if the respondents shall give a bond in the sum of $20,000 conditioned for the payment of such sum (if any) as may be decreed in favor of complainants on the final hearing of this cause. The bond to be filed with the clerk of the court and to be approved by the clerk or by a judge of the court within twenty days from this day.

Effect of Judge Hallett's Decision.

The decision unquestionably was a surprise to the electrical fraternity in general. The unbroken series of decisions in favor of the Edison interests already rendered, as well as the quietness with which the case was prepared and conducted, all pointed to a similar result in this suit. To those who were present at the trial, however, and who closely followed the case, it was apparent that the judge was impressed with the quality and quantity of the evidence brought forward by the defendant, and a decision in favor of the Columbia Incandescent Lamp Company was not a surprise to many, and was even confidently predicted by some.

From a strictly legal point of view the opinion rendered by Judge Hallett does not in any way definitely settle the great struggle between the Edison interests and the outside manufacturers. Although the judge has clearly and quite positively defined his views on this motion for a preliminary injunction, it is not to be inferred that he would necessarily render a similar decision when the case was brought to final hearing. In fact he might, upon the presentation of the case at final hearing and the examination of the witnesses whose affidavits were introduced in the preliminary hearing, reverse his own decision. However much the ultimate result of the suit may interest the counsel on either side, or even the litigating companies, it is not of so much moment to the general public, since it is generally believed that the patent in suit will expire before the case can be brought to a close.

The real interest centres on the effect of the decision from a practical or commercial standpoint. Has the General Electric Company been effectually checked in its attempt to secure a complete monopoly of the incandescent lamp business? Can the Columbia Incandescent Lamp Company and the remaining companies against whom action has not yet been brought, continue the manufacture of lamps? Can the lamp companies already enjoined take steps, with any prospect of success, toward the vacating of their injunctions? or can new companies be formed without the certainty of being at once restrained? These are questions which every one interested in the lamp industry is now asking.

The consensus of opinion seems to be that the monopoly of the incandescent lamp business has passed from the hands of the General Electric Company. If a company owning such patent rights succeeds in closing up every rival manufacturer save one, and that one is left in the field to pursue its business unmolested, the apparent monopoly of the company is of comparatively little value. It seems to be admitted on both sides that there are only two courses which are open to the General Electric Company, one to push the case to a final hearing, the other to let the whole matter drop and to allow the Columbia Incandescent Lamp Company and other companies that are not yet enjoined to continue their business as heretofore. In case the first line of policy is pursued, it will be necessary to examine at final hearing the several hundred witnesses whose affidavits have been introduced in the trial, and in all probability this would cover an extended period, during which it is generally believed that the Edison patents will have expired. If, on the other hand, no further action is taken by the General Electric Company, of course the few remaining companies can manufacture lamps, and it will then be possible to obtain lamps of other than the Edison make with almost as much ease as before the decision of the great patent suit.

When a motion for a preliminary injunction is refused, there is, it is claimed by those well versed in patent law, no right of appeal. The only legal step that can be taken is to press the matter to a final hearing, which occurs in the same circuit and probably before the same judge. After that decision is reached, however, it can be carried to the U. S. Circuit Court of Appeals.

The effect of this decision upon the companies against whom injunctions have already been granted is also a question of great interest. It is now possible for the enjoined companies to ask the court which granted the injunction to vacate that injunction on the ground that new evidence has arisen. In this case the question would be argued before the judge in the same way that was done on the motion for a preliminary injunction, and the judge will render an opinion in the same manner as before. As to whether such a motion to vacate these injunctions would be successful before the Eastern judges is a question which can only be decided by trial, and upon which there seems to be considerable difference of opinion. One well-known lawyer expresses the opinion that Judge Colt would not reverse his own decision in the face of the new evidence, and that his decision would probably serve as a precedent for all Eatern judges; while in the West it is highly probable that opinions along the same line as that of Judge Hallett's would be the result of any suit brought there. It is considered quite certain that any decision hereafter rendered in the same circuit upon a motion for a preliminary injunction would accord with that of Judge Hallett.

According to this the prospects for the Western lamp manufacturers seem bright. The Columbia Incandescent Lamp Company and the two or three other companies not yet enjoined can, it is claimed, proceed to manufacture lamps, and there is reason to believe that new companies organized in the West, especially in the judicial circuit in which the recent opinion was rendered, will enjoy the

same privilege. If such is the case the atmosphere of the electrical field is greatly clarified, and the state of uncertainty which has existed for the past few months is relieved.

The effect of the decision upon the Sawyer-Man Company and the other companies in this section can hardly be estimated at present. The New York judges have never been called upon to render an opinion on what is now known as the "Goebel defense," and it is impossible to predict what their attitude on this question would be. The Westinghouse Company is interested at present in the manufacture and sale of its new stopper lamp, and apparently has not taken an such active interest in the recent lamp litigation as the other smaller companies.

The opinions of those especially interested in this line, and whose position and experience renders them able to speak with intelligence, is always of interest, and several of them are given below. One gentleman, thoroughly posted on the suit of the Columbia Incandescent Lamp Company, expresses himself as follows:

"The General Electric Company now has but two courses before it. It must either press the St. Louis suit to a final hearing, which involves the examination of several hundred witnesses and the consumption of several years time, during which the Edison patent will expire, or it must let the matter drop where it is. It must decide for itself."

Mr. Park Benjamin, whose wide acquaintance with patent law lends special interest to his opinion, expresses the following views:

"The decision simply shows that a state of facts not sufficient to raise a doubt as to the validity of a patent in the mind of one judge, may be sufficient to raise that doubt in the mind of another. And this is all that has been done. It was not necessary to anticipate the patent on a motion for preliminary injunction, to have that motion denied; so that it seems to me hardly safe to jump to the conclusion that the Edison patent will be or even is now substantially overthrown, although it is true, owing to the short lifetime which remains in that patent, that a final disposition of the case in court cannot probably be reached before the Edison right will expire.

"I am perfectly unbiased in this matter, having no professional interest in either side of the controversy, direct or indirect. I do not hesitate to express the opinion, however, that if ultimately it be judicially determined that Mr. Goebel did, at the time he says, make the invention which he claims, such a decision will amount to an attestation of a miracle. There is such a thing as history and such a thing as progress in this world; and an invention is the product of both man and the conditions which surround him. That Goebel may have made a lamp like one of the old forms, which were adduced at the various earlier trials in anticipation of Edison's lamp may be possible; but that Goebel did what Edison did, and nearly twenty years before, I refuse to believe for the same reason that I refuse to believe any other statement, which, in the light of known historical progress, does violence to common sense.

"The foundations of the great Roman Catholic Cathedral on Fifth Avenue, if I remember rightly, had been laid at the time Mr. Goebel claims to have had his lamp. For many years the church was unbuilt, but finally it was erected, and then, after a lapse of more years, the two graceful steeples completed the architect's work. Following the Goebel precedent, perhaps thirty or forty years hence, some may rise and remark:

"'Do you see those two beautiful marble steeples up there in the air? Well, I built them about 1865.'

"'Why, how could you do that?' answers the surprised recipient of this astounding information. 'The church itself was not built then, and those steeples would not stay up in the air by themselves, even if you accomplished the miracle of putting them there.'

"'I don't know and I don't care. All I know is that I had them up there. Witter & Kenyon can explain it better than I can. If you don't believe it, you are a hireling of the cathedral architect. Here are several of my friends from the East side who saw those steeples then, and here are Messrs. Pope & Cross, who are of opinion that on that part of the earth's surface at that time, the attraction of gravitation gave out. That settles it. Vilifier, avaunt.'

"'And yet I doubt whether the citizen of the next century would be convinced by that argument.

"'My good child,' said the pious missionary to the puzzled infant from the slums, unable to grasp the metaphysics of a miracle, 'suppose I should tell you that last night I saw two moons? What would you then say?'

"'Say yer lied!'

"'Tut-tut; I am a clergyman, and I tell you I do not lie. Now, what would you say?'

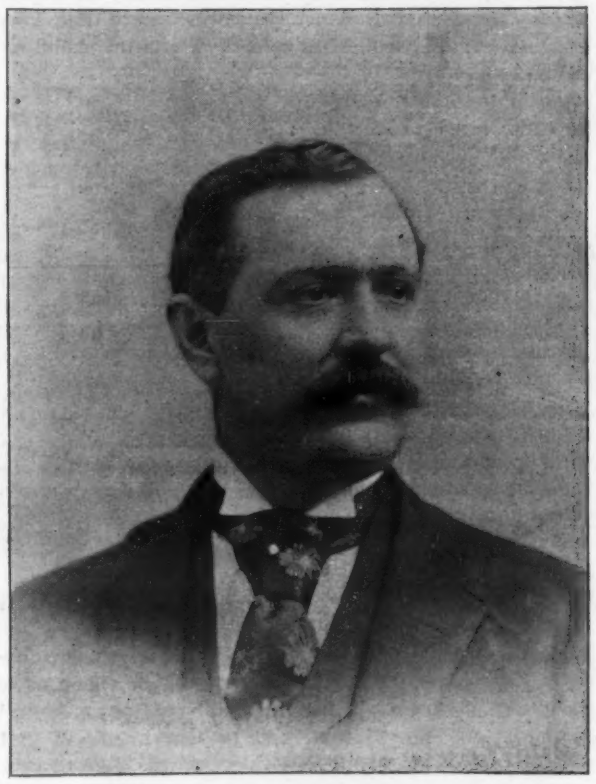
"'Say yer wuz drunk!'

"And, alas, such I fear will ever be the attitude of the skeptical world toward the miracle of to-day."

The president of one of the alleged infringing lamp companies stated that he was not surprised at the result, as the case at Boston had been so hurriedly prepared that the defense was not in a position to counteract the unfavorable impression produced on Judge Colt by the startling nature of the Goebel claim. The General Electric Company, in his opinion, would be deterred by this decision from proceeding against other alleged infringing companies until the final hearing, the course of which, however, might be necessarily prolonged to almost the date of the expiration of the patent.

One of the counsel of the General Electric Company stated that while the plaintiffs recognized the decision of Judge Hallett as a reverse, yet they considered it only a temporary one which would be overcome at the final hearing. The decision was the result of a very conservative view on the part of the court, and merely implied that in Judge Hallett's opinion the claims of Goebel should not be summarily disposed of, but given an opportunity to be presented in regular course where witnesses could be cross-examined and the matter fully investigated. The probabilities are that neither the decision of Judge Hallett nor that of Judge Colt would have been different if the former had rendered his opinion on the record of the Beacon case and the latter on that of the Columbia case. In short, the decision means that Judge Hallett, unlike Judge Colt, was not prepared to dispose of Goebel's claim summarily, and his action merely gives the defense a statue for trial by regular procedure. Similar refusals to grant preliminary injunctions were met with in the Bell telephone suits without affecting the final result. The decision will not affect the view previously held by the General Electric Company in regard to the other infringing companies, and the Columbia case will be vigorously prosecuted to a final decision.

Mr. H. Ward Leonard stated that the favorable decision at St. Louis would bring into greater prominence the remarkable nature of the Goebel defense. That one working under relatively unfavorable conditions should independently evolve the several vital principles concerned in a successful incandescent lamp seemed marvelous, and if the claim is established it will take rank as one of the curiosities of invention. Aside from the



MR. J. H. RHOTEHAMEL.

all-glass exhausted receiver and platinum leading-in wires, that a material like bamboo should have been chosen, and then further made into a filament of high resistance, is most remarkable in view of the elaborate and extended experiments with unrivaled facilities that preceded Edison's discovery of the same material and principle. Mr. Leonard thinks that the Hallett decision will not prevent the General Electric Company from pushing the matter to a final decision, nor change their intentions in regard to proceeding against the other alleged infringing companies. In the latter case, however, the probabilities are that a new line of defense will be vigorously presented and keep up interest in what will be regarded as a historic litigation.

J. H. Rhotehamel, President of the Columbia Incandescent Lamp Company.

Mr. J. H. Rhotehamel was born Oct. 20, 1857, on a farm in Miami County, O., where he remained until he was 15 years of age, acquiring his early education in a country school, after which time he attended Antioch College, at Yellow Springs, O., not completing the course, however. After leaving school he engaged in teaching, and then went into the real estate and investment business, which business he pursued up to the time of entering the electrical business.

After leaving Ohio he spent a few years in Chicago, and then went to St. Louis in July, 1889, immediately organizing the present firm, the Columbia Incandescent Lamp Company, whose prosperous business has depended largely on his individual efforts.

Mr. Rhotehamel is entirely self-made, and has made his way in the world entirely unassisted, having only received $100, which was given him at the age of 21 years.

Soon after the Columbia Incandescent Lamp Company was sued by the Edison Electric Light and the Edison General Electric companies, Mr. Rhotehamel made a personal investigation of the Goebel prior use, and after carefully investigating the same was impressed with its genuineness and truth, and immediately made arrangements to use this defense in the case just heard. When the decision was handed down by Judge Colt, granting an injunction against the Beacon Vacuum Pump and Electrical Company, he was somewhat surprised, but did not lose his confidence in the genuineness of the defense and the final outcome of it; and even though almost the entire electrical world had then concluded it would be useless to present this defense further, he advised his company to make it, and after presenting all the facts to local counsel, Mr. C. C. Fowler, of the firm of Fowler & Fowler, and Judge E. B. Adams, of the firm of Boyle & Adams, on their advice proceeded to prepare the defense, with the result as shown in the case just tried. But for Mr. Rhotehamel's confidence and persistency this defense would have been abandoned, and the Goebel matter never presented further.

Those who have followed the arguments in this case as presented in the columns of THE ELECTRICAL WORLD for April 22 cannot fail to have been interested in the admirable defense which Mr. Rhotehamel's confidence and persistency in the matter have given to the world. Whatever may be the views of our readers in this matter, Mr. Rhotehamel's position and attitude must have challenged their admiration, and the electrical public owe him and his company a debt of gratitude for the fight they have made, almost single-handed, for what they believed was right. This case has, in fact, made history, for had not this trial taken place, one of the most important chapters in the history of electrical invention must have remained unwritten.

At the time of the Beacon trial the whole electrical fraternity awaited almost with bated breath the outcome, and in anticipation of the result those most unfavorably affected by the previous rulings entered into a compact for mutual defense. Had Judge Colt ruled in favor of the Beacon company, their course would have been clear. It having been otherwise, however, a split occurred in their councils as to what should be their future course. The majority considered Goebel defense untenable. Mr. Rhotehamel thought otherwise, and a break in the ranks of the opposition to the General Electric Company ensued, and the subject of this sketch was left alone to back his own judgment.

But the same good judgment which has marked Mr. Rhotehamel's career in the past, and enabled him to surmount seemingly impassable barriers before, has been demonstrated by the result in the present case. While no one can censure those who, differing in opinion from Mr. Rhotehamel, refused to lend assistance in this fight, which was for a common cause, there cannot but be a feeling among those who have borne the brunt of the fray that the fainter-hearted must regret their position. Mr. Rhotehamel, on the other hand, must review this latest step in his career as the brightest of all, and THE ELECTRICAL WORLD is not the least of all his friends in extending to him and to the company he represents, as well as to the attorneys who successfully engineered the case, their most hearty congratulations for the great fight made and the important victory won.

Praise for the St. Louis Lamp Report.

A number of very gratifying compliments have come to THE ELECTRICAL WORLD regarding its elaborate report of the St. Louis Edison-Columbia lamp case. It was the only journal present at the trial, and of course the only one that had a complete or satisfactory report of the proceedings. One of its editors and its own special artist had gone all the way to St. Louis to report the case and illustrate the exhibits.

Mr. W. S. Kaliske, manager of the Beacon Vacuum Pump and Electrical Company, of Boston, who was the first to bring forward what has since become known as the "Goebel defense," writes as follows:

"Your report of the St. Louis lamp case in this week's issue of your esteemed journal not alone deserves the high regard of your subscribers, but of the public in general. The promptness displayed by you in publishing the case so elaborately is highly commendable, and we are pleased to evidence our appreciation of the same. Your courteous recognition of the efficient manner displayed by Messrs. Witter & Kenyon in their arguments in the case for the defendants will be highly gratifying to the friends of these able attorneys, who have watched their untiring efforts while assembling the features of this important defense."

Mr. J. H. Rhotehamel, of the Columbia Incandescent Lamp Company, to whose personal exertions the success of the recent case is doubtless in large measure due, says:

"I have noticed, with interest, your review of the lamp suit last week, as published in THE ELECTRICAL WORLD of April 22, and have been very much gratified with the manner in which you handled the case. It is a fair and impartial presentation of the matter."

Mr. A. S. Terry, secretary and treasurer of the Sunbeam Incandescent Lamp Company, of Chicago, who was present during a part of the hearing at St. Louis, has to say:

"I wish to compliment you on the full and complete report of the hearing in the case of the Edison Electric Light Company against the Columbia Incandescent Lamp Company, at St. Louis, published in your issue of April 22.

"Having been present during part of the hearing and taking great interest in the presentation of the case, I became familiar with the essential points in it, and notice that your report brings them out in a very full and complete manner.

"As this decision is likely to prove of vital importance to the electrical industries, you deserve great credit for the enterprise shown in publishing such a full and complete report."

Mr. F. H. Prentiss, president of the Buckeye Electric Company, of Cleveland, O., gives this as his opinion:

"Your report of the proceedings in the incandescent lamp case at St. Louis deserves acknowledgment from the electrical fraternity, individually and collectively."

Mr. J. H. Cooke, Chicago agent of the same company, gives his views in the following characteristic language:

"THE ELECTRICAL WORLD generally does business on the 'While you're gittin', git a plenty' plan. You got all that was to be had from the St. Louis incandescent lamp proceedings, and have given it to your readers in splendid form, for which you should receive some thanks and *many* 'ads.'"

Mr. F. S. Terry, manager of the Ansonia Electric Company, which handles large quantities of all classes of electrical apparatus, and is therefore an excellent representative of the electrical supply industry, says:

"I consider the publication in THE ELECTRICAL WORLD of the full argument and exhibits of the Columbia incandescent lamp case an evidence of unusual journalistic enterprise and one that should be much appreciated by the electrical fraternity."

Single Phase Alternating Current Motors.

BY ELIHU THOMSON.

I do not think that the letter of Mr. Brown, in your issue of April 22, 1893, affects my contention that motors, working on a principle the discovery of which he had stated was the result of his own observations, were known in the art. I called attention in my letter to which he refers to my patent No. 407,344, in support of my assertion. I also stated that I had experimented with various forms of these motors, and I will now be more explicit in relation to them. One of my first motors had the relation of its field coils and armature as 1 : 3; that is to say, the field circuit through which alternating currents were passed, being single, there were three armature circuits closed when running.

Other motors made in 1889 have numerous armature circuits in relation to the field coils. I tried smooth winding, but always found the projection armatures more effective.

None of these motors were synchronizing motors, as Mr. Brown seems to think, but behaved just as he has stated in the words "only when running light will the speed approach synchronism. When loaded the speed of the rotating part sinks so far below synchronism that the current produced by this difference of speed gives the necessary torque. The extent of this drop depends on the form of the rotating part, etc.," when referring to his modification.

In my patent the statement is made that "many arrangements of coils and cores may be used." Mr. Brown in his last letter says, referring to the work of Mr. Tesla and myself, "but I would point out that certain points in their machines were inherently defective, and that it was only by remedying these that I have been able to produce a practical single phase motor." In other words, as I understand it, Mr. Brown in 1892 has remedied defects of motors the principles of which he now admits have been known a long time since. If this be so, then my original contention remains. Further, I submit that the remedies applied are just those which have been applied to all classes of electrical machinery in the past few years—a more intelligent use of iron projections than formerly. I have the greatest admiration for the skill and engineering ability shown by Mr. Brown in his work, but must insist on the identity of principle of his motor and those which preceded it.

In the statement at the close of his letter regarding the high frequencies in vogue in America, and "that there was nothing to prevent the adoption of a lower frequency in the then early stage, etc.," he assumes a familiarity with American conditions in 1888-1889. The statements he makes show conclusively that he does not and did not possess this familiarity. The great demand for an alternating single phase motor in 1888-1889, and even now, is for one which will go upon the existing lines distributing alternating currents of 125 to 130 frequency. The actual fact was that in America up to 1889 these frequencies had been largely introduced, and the desire for uniformity has continued the practice even to the present, when we know much better than we did then what the practical differences in the use of high or low frequencies are. There is now, indeed, a tendency in America to come down to lower frequencies, but it is as yet little more than a tendency. Let us suppose that we had in our possession, on sale, a few hundred of Mr. Brown's modification of the single phase motor here in America, and of all sizes and capacities, and then put the question: Could we sell them to run on existing systems practically, economically and satisfactorily? and the bearing of the high frequency question, even to-day, in spite of tendencies, will be emphasized in the answer.

Theodore Puskas.

(By Our Special Correspondent.)

The recently announced death of the electrician, Theodor Puskas, in his home in Budapest, recalls some of his experience in the United States, where he was well known. His persistency is shown by the following incident: Being interested in the statements about the famous Keely motor in Philadelphia, he tried to obtain permission to see the motor, but as this was denied him he rented a house in the neighborhood and starting from his yard he excavated a tunnel leading into Keely's laboratory, where he suddenly made his appearance in the night; after this he was permitted to work with Keely and spent many months with him. Being honest, however, he soon found that Keely was a swindler, and that he produced his wonderful results by hidden reservoirs of compressed air. On hearing this the stockholders offered him a large sum of money in order to keep quiet about it, but he refused and exposed the fraud in the newspapers.

When he first heard of the invention of the telephone he immediately went to Edison to buy his invention for Europe. Edison is said to have laughed and not to have believed that the invention had any such great practical value; nevertheless Puskas obtained the right for the whole of Europe except England, while a friend of his is stated to have obtained the right for America for $75,000, a right which afterward yielded many millions. Puskas sold his right for the whole of Europe, except Paris, where he, himself, started an exchange, all of which he owned himself.

He was very much interested in the problem of aerial navigation, and spent much time and money in experiments, the results of which, however, were not very satisfactory. He soon after sold the Paris telephone exchange and returned to his home in Budapest, where he endeavored to start a telephone exchange. Not meeting with any encouragement, however, he again went to America, where he said he had always met with success and encouragement, at the same time complaining bitterly that his work was not appreciated in his own country. In his checkered career he kept returning to his pet idea of aerial navigation, with which he proposed to make war impossible.

His last work was the introduction, in his own home, of what is known as the telephone newspaper, described recently in these pages, by means of which news was distributed to subscribers by telephone from a central news station. The system is at present in use in that city, and is stated to meet with approval. Before this, nobody had yet succeeded in arranging a telephone so that several hundred persons could hear the same message at the same time. This obstacle, however, he is said to have overcome completely, and it is stated that now half a million people can receive the same telephone message simultaneously with great distinctness. In his experiment, speech transmitted in Budapest was heard simultaneously in Vienna, Gratz, Trieste, Prague, and Bruenn. A speaker with a very loud voice, in a closed building, cannot be heard by more than 20,000 at one time, and even then the more distant ones cannot hear very distinctly, but with Puskas' latest improvement half a million can hear the same voice by telephone with even greater distinctness.

His intention was to bring out his invention first in America. His patriotic feeling, however, led him to introduce it in his own country first. With this invention he has made it possible that a monarch can talk with all the inhabitants of his kingdom as if he were addressing them directly. His last invention was a great improvement in long distance telephony. There was only one point left to be worked out, which he succeeded in overcoming, but communicated it to no one except possibly a Viennese professor. It is not unlikely, however, that his secret died with him.

He was a most indefatigable worker, seldom taking any rest. Personally he was a most pleasant companion when not annoyed by failure. He enjoyed, particularly, playing innocent jokes on people, and even on the evening before he died, only a few hours before, he got out of bed rang up his brother by telephone and teased him by transmitting some important ficticious news in a disguised voice. Toward his friends he was self-sacrificing in the highest degree, and at one time, although not at all wealthy, he invited a friend to take a trip with him over the whole of the United States, paying all the expenses himself. In his death, Hungary loses one of its leading and most energetic electricians.

Explosion of a Storage Battery.

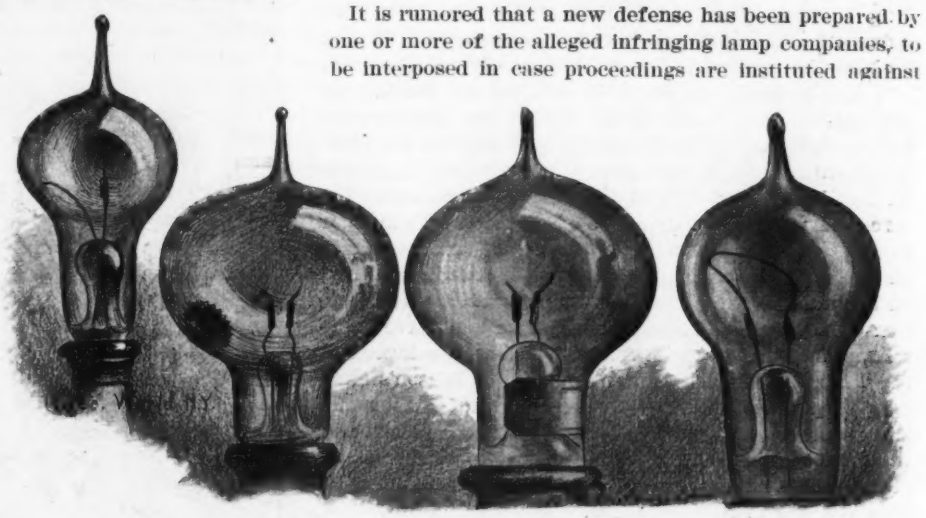
Mr. F. C. Bliss, of the Bliss Engineering Company, Washington, D. C., sends us an interesting account of an explosion of a storage battery which, fortunately, in this instance, had no serious results. Seven Julien cells being charged from a 110-volt circuit with 10 amperes, were disconnected while in circuit by disconnecting the wire joining the middle cell to the adjacent one, in order to put in another cell. At the instant of breaking connection there was a vivid flash followed by a loud explosion; the cell was completely wrecked and several persons standing near were thrown backward and deluged with acid. The heavy iron clamps which secured the top to the sides of the cell were forcibly broken and the iron handle thrown to the ceiling, breaking out a section of lath and plaster where it struck.

The explosion, of course, was due to the spark caused by breaking the circuit igniting the uncombined hydrogen and oxygen gases in the cell. A similar accident occurred in Pittsburgh several years ago with serious results; in this case the cells were in a box closed with a lid, and the explosion occurred while an examination was being made by the aid of a candle, the flame of which ignited the gases that had accumulated before the lid was raised.

Other cases have been noted, and as uncombined gases are always present near the end of a charge, due to the fact of the plates only taking up a portion of the gases released at that time, great care should be exercised in approaching a light or breaking a connection where the situation is such that the gases may have had an opportunity to accumulate. Closed cells such as are used with phonographs are particularly liable to this accident.

New Lamp Defence.

It is rumored that a new defense has been prepared by one or more of the alleged infringing lamp companies, to be interposed in case proceedings are instituted against them by the General Electric Company. The defense, it is said, will be based upon the priority of Swan as the inventor of the incandescent lamp. It will be held, according to rumor, that the consolidation of the Swan and Edison interests in England prior to the conclusion of the suit between them resulted in the merits of case being only partially developed there.



HAMMER'S EXHIBIT NO. 7.

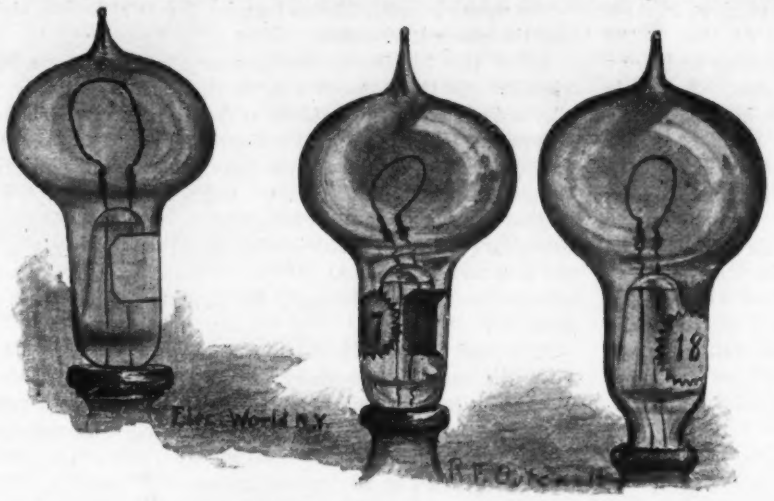
Electrical Insurance Risks.

An interesting point is considered by Mr. F. W. Fairfield, city electrician of Nashville, Tenn., in a recent communication, which the discussion of insurance at the meeting of the National Electric Light Association prompted him to send. He states that the underwriters have always laid great stress upon the interior wiring of buildings and its thorough and careful inspection, which is unquestionably right and necessary. He adds, however, that the inspection of exterior wires is quite as essential if the least fire risk is to be attained The majority of fires which are attributed to electrical causes do not appear to result from interior wiring entirely, but from crosses and troubles in the outside wires, often a considerable distance away. It is to be noted that interior wires, after having been once placed and properly insulated, are likely to remain in that condition without disturbance; but in the case of exterior wires, they are constantly being changed, new circuits being added, old wires being taken down, and so forth. Moreover, telephone, telegraph, light and power wires will often be found using the same streets, sometimes the same poles, and frequently crossing and recrossing in close proximity to each other. It is evident that where changes are frequently made in these wires there is great danger of their being crossed or grounded, and even the telegraph and telephone wires, innocent enough in themselves, may be the means of carrying a current into some building which is ill prepared to receive it. The underwriters can hardly exercise any authority over the wires in the streets, or if they assume such it is with great difficulty enforced. The city authorities have exclusive supervision here, and their orders are alone likely to be obeyed. A continual inspection of exterior wires and the exercising of a general supervision of all construction work and changes, as well as the methods and means em-

ployed for making connections with buildings, the running of wires around cornices, placing guards over trolley wires, etc., would reduce to a great extent the danger of fires from electrical sources.

The Story of the Evolution of the Edison Incandescent Lamp.—II.

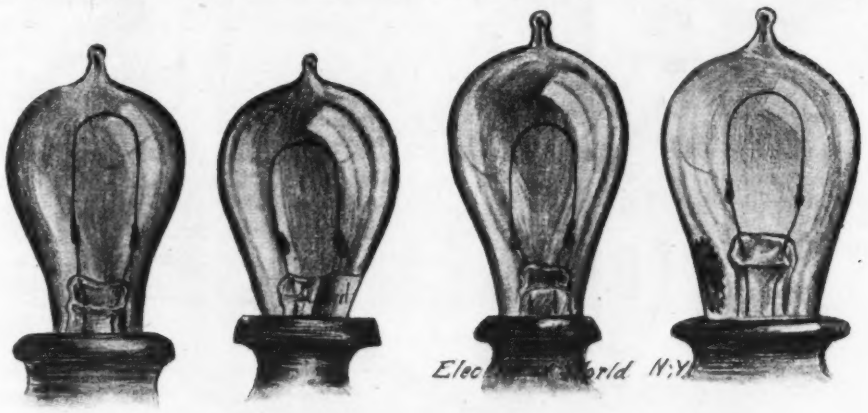
Hammer's Exhibit No. 6 shows four lamps which embody the following features: A rounded bulb with elongated neck, the inside part also rounded and hollow; and



HAMMER'S EXHIBIT NO. 8.

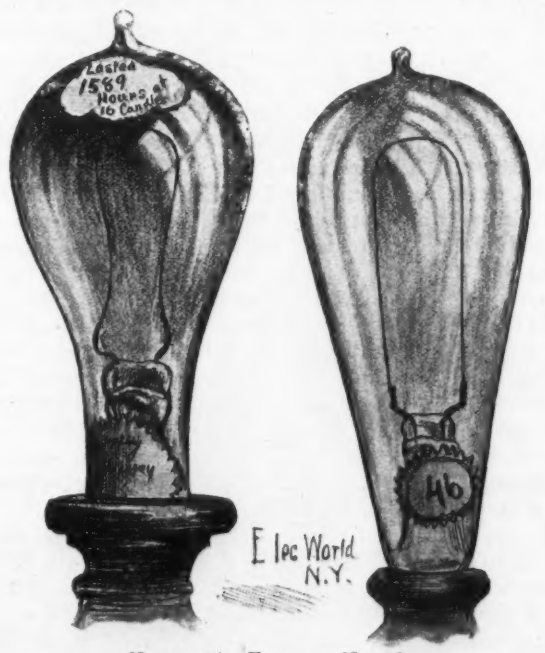
where the platinum leading-in wires are sealed onto the glass at the top of the inside part the glass is drawn up around the wires; the tips on the globe are somewhat pointed and hollow; the carbons are of the paper horseshoe type and are held by platinum clamps which are clearly shown. These lamps were made late in the year 1879 (November or December).

Hammer's Exhibit No. 7 shows similar lamps embodying several changes. It will be noted that the two lamps in the centre of the illustration are considerably larger than heretofore, and it was believed at that time that the lamps would last longer in a larger inclosing chamber. Note that



HAMMER'S EXHIBIT NO. 10.

the tops of the lamps have long supplemental tips of solid glass. It was believed at this time that air leaked into the globes at the point where the lamp was sealed, and it has been the practice up to within the past six or seven years to place these supplemental tips upon the globes. It must be noted that the sealing of the glass where the globe is

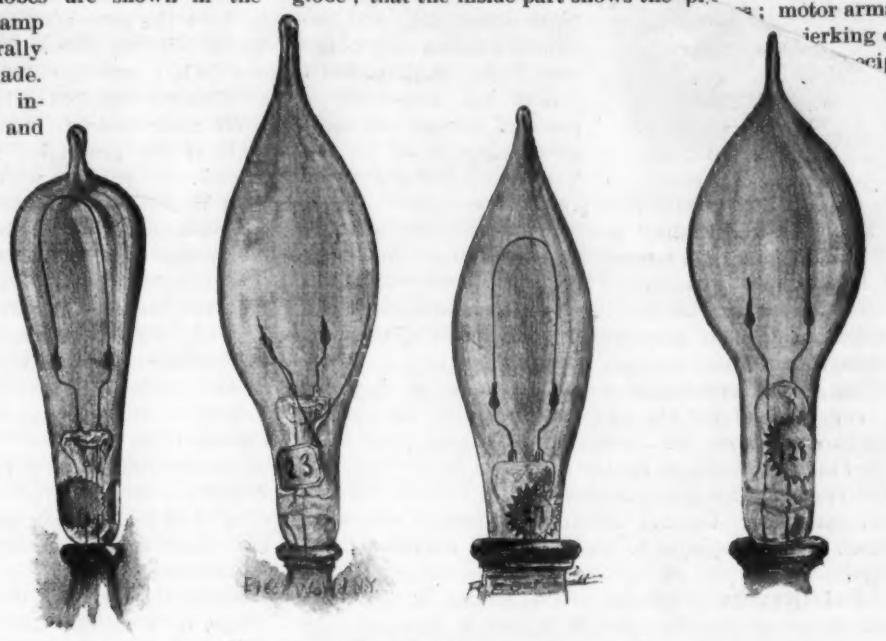


HAMMER'S EXHIBIT NO. 12.

joined onto the inside part is very roughly done in all of these early lamps, although the glassblowers who did this work were probably as skillful as any in the country at that time. These lamps were made very early in 1880.

Hammer's Exhibit No. 8 shows the use of a soft white German glass at the top of the inside part to effect a more perfect seal where the platinum wires pass through the glass. Lamps 2 and 3 also show a new form of paper filament. These lamps were made in the spring of 1880.

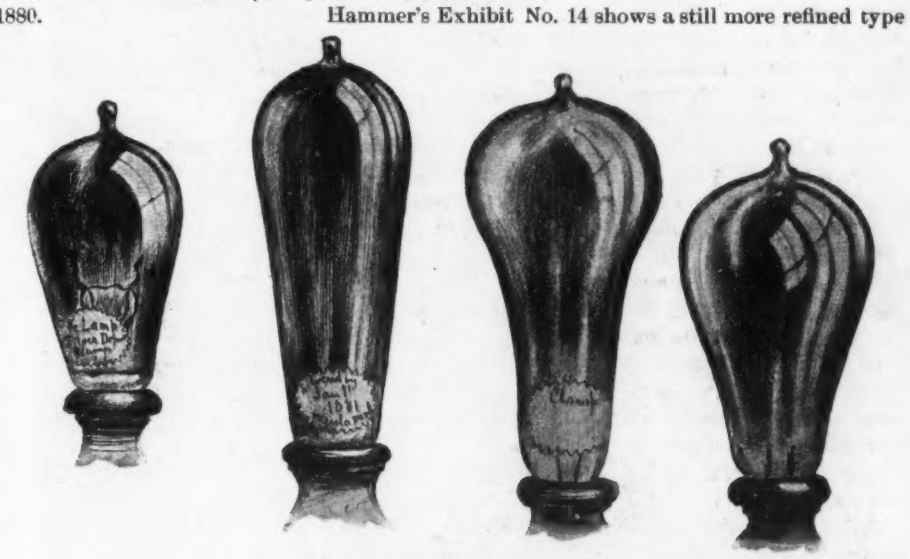
Hammer's Exhibit No. 9 shows a radical departure in the shape of the globe, necessitated by the use of the long, high-resistance bamboo filaments, which Mr. Edison had decided to employ. Two shapes of globes are shown in the illustration. No. 1 is the first lamp of the type of globe now so generally in use which was ever made. It will also be noted that the inside part has been depressed and



HAMMER'S EXHIBIT NO. 9.

the glass drawn up around the platinum wires, and the use of the white German glass has ceased. In Nos. 1, 2 and 3 the clamps are of nickel, and the difference between this clamp and the platinum clamp may readily be seen by comparing it with the clamps in No. 4. The sealing of the outside globe to the inside part is still very irregular, and is particularly noticeable in Nos. 2 and 4. These lamps were made early in the fall of 1880.

Hammer's Exhibit No. 10 shows a set of eight-candle lamps, or, as they were at that time called, "B" lamps,



HAMMER'S EXHIBIT NO. 11.

the filament being of bamboo, and one-half the length of 16-candle lamps. It will be noted that a standard form of globe has now been adopted; that the supplemental tips on the tops of the globes have been shortened and improved in appearance; that the inside part has been squeezed together while hot, so that the platinum leading-in wires pass through a large piece of solid glass. Lamp No. 2 shows a slightly different shape of clamp. This is made of silver; the others are of platinum. Particular attention is called to the butt of the lamp, which is made of wood, and into which the lamp is inserted. The wires leading from the lamp are soldered to contact rings insulated from each other, one plain and the other threaded, to facilitate making contact in the lamp socket. These lamps were made in the winter of 1880.

Hammer's Exhibit No. 11 shows an experiment with silver-plated clamps. At this time experiments were being made with both silver and copper, to save the expense of the platinum clamps, which, up to that time, had been the standard, and also to make the contact between the platinum wires and the carbon filament better. The silver is plainly shown in lamp No. 1, and in the other three lamps in the illustration the silver has been volatilized and deposited upon the lamp globe. These lamps were made in January of 1881, save No. 1, which contained an eight-candle carbon, and which was made in April, 1881. The improvement in the glass seals of the lamp is noticeable in these lamps and all lamps made at this period.

Hammer's Exhibit No. 12 shows two of the earliest copper plated lamps, and attention is called to the very thick deposit of copper around the shanks of the carbon and leading-in wires. The first lamp in the illustration was considered at that time a phenomenal lamp, as it was the first incandescent lamp which had made a long record, having lasted 1,589 hours at 16 candles. I remember the great interest which it attracted in the laboratory, and secured permission to keep this lamp when it gave out. The labels were placed upon it by me at that time. These lamps were made in the spring of 1881.

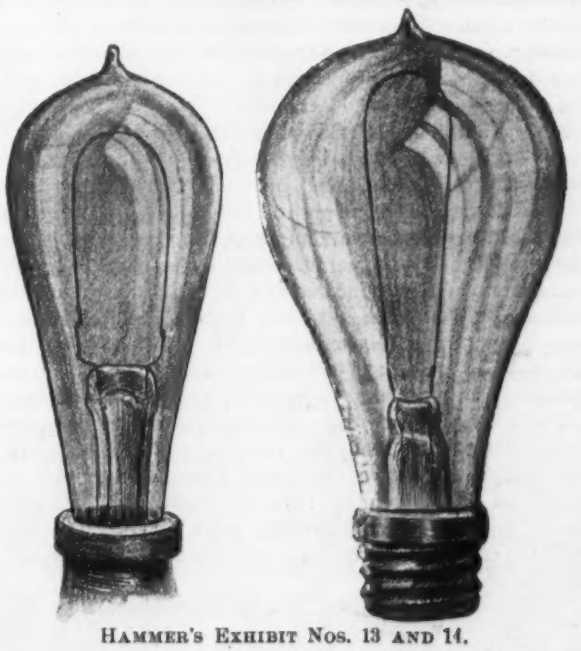
Hammer's Exhibit No. 13 shows a set of the standard copper-plated lamps. These lamps were adopted as the

standard ty[illegible]ing coal, gas or oil may be stated as follows base of these lam[illegible]rom smoke, gas, odor, heat, ashes, cinfall or winter. It wi[illegible]or things of the kind that greatly lamps is much lighter th[illegible]ers in previous styles of there is a general uniformity in [illegible]from noise, whether globe; that the inside part shows the p[illegible]; motor armaierking or [illegible]cip-

Hammer's Exhibit No. 14 shows a still more refined type

HAMMER'S EXHIBIT NO. 11.

of the Edison incandescent lamp and the most modern form. In the general characteristics it is the same as the lamp in Exhibit 13. The copper plating has been replaced by carbon paste, which has only come into extensive use within the past five years, the carbonized filament of bamboo is slightly finer, the supplemental tip on the lamp has been omitted, and the plaster butt on the bottom of the lamp



HAMMER'S EXHIBIT NOS. 13 AND 14.

has been made smaller, and the contact rings have given place to a brass contact plate at the bottom and the threaded brass ring, as shown in the illustration. As already stated, these lamps marked certain radical steps in the development of the Edison incandescent lamp. There are many features of minor importance and a thousand and one experiments have been tried, that have not been referred to herein.

"Having been present during part of the hearing and taking great interest in the presentation of the case, I became familiar with the essential points in it, and notice that your report brings them out in a very full and complete manner.

"As this decision is likely to prove of vital importance to the electrical industries, you deserve great credit for the enterprise shown in publishing such a full and complete report."

Mr. F. H. Prentiss, president of the Buckeye Electric Company, of Cleveland, O., gives this as his opinion:

"Your report of the proceedings in the incandescent lamp case at St. Louis deserves acknowledgment from the electrical fraternity, individually and collectively."

Mr. J. H. Cooke, Chicago agent of the same company, gives his views in the following characteristic language:

"THE ELECTRICAL WORLD generally does business on the 'While you're gittin', git a plenty' plan. You got all that was to be had from the St. Louis incandescent lamp proceedings, and have given it to your readers in splendid form, for which you should receive some thanks and *many* 'ads.'"

Mr. F. S. Terry, manager of the Ansonia Electric Company, which handles large quantities of all classes of electrical apparatus, and is therefore an excellent representative of the electrical supply industry, says:

"I consider the publication in THE ELECTRICAL WORLD of the full argument and exhibits of the Columbia incandescent lamp case an evidence of unusual journalistic enterprise and one that should be much appreciated by the electrical fraternity."

Single Phase Alternating Current Motors.

BY ELIHU THOMSON.

I do not think that the letter of Mr. Brown, in your issue of April 22, 1893, affects my contention that motors, working on a principle the discovery of which he had stated was the result of his own observations, were known in the art. I called attention in my letter to which he refers to my patent No. 407,344, in support of my assertion. I also stated that I had experimented with various forms of these motors, and I will now be more explicit in relation to them. One of my first motors had the relation of its field coils and armature as 1 : 3; that is to say, the field circuit through which alternating currents were passed, being single, there were three armature circuits closed when running.

Other motors made in 1889 have numerous armature circuits in relation to the field coils. I tried smooth winding, but always found the projection armatures more effective.

None of these motors were synchronizing motors, as Mr. Brown seems to think, but behaved just as he has stated in the words "only when running light will the speed approach synchronism. When loaded the speed of the rotating part sinks so far below synchronism that the current produced by this difference of speed gives the necessary torque. The extent of this drop depends on the form of the rotating part, etc.," when referring to his modification.

In my patent the statement is made that "many arrangements of coils and cores may be used." Mr. Brown in his last letter says, referring to the work of Mr. Tesla and myself, "but I would point out that certain points in their machines were inherently defective, and that it was only by remedying these that I have been able to produce a practical single phase motor." In other words, as I understand it, Mr. Brown in 1892 has remedied defects of motors the principles of which he now admits have been known a long time since. If this be so, then my original contention remains. Further, I submit that the remedies applied are just those which have been applied to all classes of electrical machinery in the past few years—a more intelligent use of iron projections than formerly. I have the greatest admiration for the skill and engineering ability shown by Mr. Brown in his work, but must insist on the identity of principle of his motor and those which preceded it.

In the statement at the close of his letter regarding the high frequencies in vogue in America, and "that there was nothing to prevent the adoption of a lower frequency in the then early stage, etc.," he assumes a familiarity with American conditions in 1888-1889. The statements he makes show conclusively that he does not and did not possess this familiarity. The great demand for an alternating single phase motor in 1888-1889, and even now, is for one which will go upon the existing lines distributing alternating currents of 125 to 130 frequency. The actual fact was that in America up to 1889 these frequencies had been largely introduced, and the desire for uniformity has continued the practice even to the present, when we know much better than we did then what the practical differences in the use of high or low frequencies are. There is now, indeed, a tendency in America to come down to lower frequencies, but it is as yet little more than a tendency. Let us suppose that we had in our possession, on sale, a few hundred of Mr. Brown's modification of the single phase motor here in America, and of all sizes and capacities, and then put the question: Could we sell them to run on existing systems practically, economically and satisfactorily? and the bearing of the high frequency question, even to-day, in spite of tendencies, will be emphasized in the answer.

Theodore Puskas.

(By Our Special Correspondent.)

The recently announced death of the electrician, Theodor Puskas, in his home in Budapest, recalls some of his experience in the United States, where he was well known. His persistency is shown by the following incident: Being interested in the statements about the famous Keely motor in Philadelphia, he tried to obtain permission to see the motor, but as this was denied him he rented a house in the neighborhood and starting from his yard he excavated a tunnel leading into Keely's laboratory, where he suddenly made his appearance in the night; after this he was permitted to work with Keely and spent many months with him. Being honest, however, he soon found that Keely was a swindler, and that he produced his wonderful results by hidden reservoirs of compressed air. On hearing this the stockholders offered him a large sum of money in order to keep quiet about it, but he refused and exposed the fraud in the newspapers.

When he first heard of the invention of the telephone he immediately went to Edison to buy his invention for Europe. Edison is said to have laughed and not to have believed that the invention had any such great practical value; nevertheless Puskas obtained the right for the whole of Europe except England, while a friend of his is stated to have obtained the right for America for $75,000, a right which afterward yielded many millions. Puskas sold his right for the whole of Europe, except Paris, where he, himself, started an exchange, all of which he owned himself.

He was very much interested in the problem of aerial navigation, and spent much time and money in experiments, the results of which, however, were not very satisfactory. He soon after sold the Paris telephone exchange and returned to his home in Budapest, where he endeavored to start a telephone exchange. Not meeting with any encouragement, however, he again went to America, where he said he had always met with success and encouragement, at the same time complaining bitterly that his work was not appreciated in his own country. In his checkered career he kept returning to his pet idea of aerial navigation, with which he proposed to make war impossible.

His last work was the introduction, in his own home, of what is known as the telephone newspaper, described recently in these pages, by means of which news was distributed to subscribers by telephone from a central news station. The system is at present in use in that city, and is stated to meet with approval. Before this, nobody had yet succeeded in arranging a telephone so that several hundred persons could hear the same message at the same time. This obstacle, however, he is said to have overcome completely, and it is stated that now half a million people can receive the same telephone message simultaneously with great distinctness. In his experiment, speech transmitted in Budapest was heard simultaneously in Vienna, Gratz, Trieste, Prague, and Bruenn. A speaker with a very loud voice, in a closed building, cannot be heard by more than 20,000 at one time, and even then the more distant ones cannot hear very distinctly, but with Puskas' latest improvement half a million can hear the same voice by telephone with even greater distinctness.

His intention was to bring out his invention first in America. His patriotic feeling, however, led him to introduce it in his own country first. With this invention he has made it possible that a monarch can talk with all the inhabitants of his kingdom as if he were addressing them directly. His last invention was a great improvement in long distance telephony. There was only one point left to be worked out, which he succeeded in overcoming, but communicated it to no one except possibly a Viennese professor. It is not unlikely, however, that his secret died with him.

He was a most indefatigable worker, seldom taking any rest. Personally he was a most pleasant companion when not annoyed by failure. He enjoyed, particularly, playing innocent jokes on people, and even on the evening before he died, only a few hours before, he got out of bed rang up his brother by telephone and teased him by transmitting some important ficticious news in a disguised voice. Toward his friends he was self-sacrificing in the highest degree, and at one time, although not at all wealthy, he invited a friend to take a trip with him over the whole of the United States, paying all the expenses himself. In his death, Hungary loses one of its leading and most energetic electricians.

Explosion of a Storage Battery.

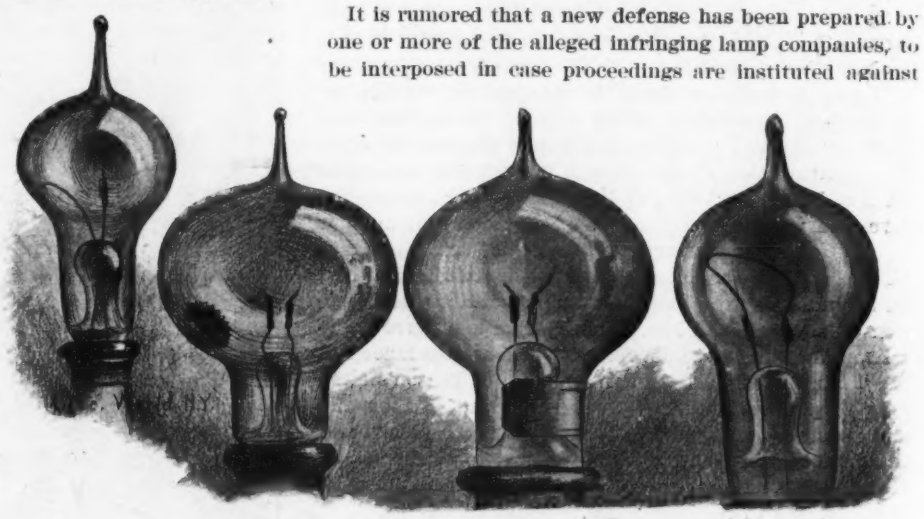
Mr. F. C. Bliss, of the Bliss Engineering Company, Washington, D. C., sends us an interesting account of an explosion of a storage battery which, fortunately, in this instance, had no serious results. Seven Julien cells being charged from a 110-volt circuit with 10 amperes, were disconnected while in circuit by disconnecting the wire joining the middle cell to the adjacent one, in order to put in another cell. At the instant of breaking connection there was a vivid flash followed by a loud explosion; the cell was completely wrecked and several persons standing near were thrown backward and deluged with acid. The heavy iron clamps which secured the top to the sides of the cell were forcibly broken and the iron handle thrown to the ceiling, breaking out a section of lath and plaster where it struck.

The explosion, of course, was due to the spark caused by breaking the circuit igniting the uncombined hydrogen and oxygen gases in the cell. A similar accident occurred in Pittsburgh several years ago with serious results; in this case the cells were in a box closed with a lid, and the explosion occurred while an examination was being made by the aid of a candle, the flame of which ignited the gases that had accumulated before the lid was raised.

Other cases have been noted, and as uncombined gases are always present near the end of a charge, due to the fact of the plates only taking up a portion of the gases released at that time, great care should be exercised in approaching a light or breaking a connection where the situation is such that the gases may have had an opportunity to accumulate. Closed cells such as are used with phonographs are particularly liable to this accident.

New Lamp Defence.

It is rumored that a new defense has been prepared by one or more of the alleged infringing lamp companies, to be interposed in case proceedings are instituted against them by the General Electric Company. The defense, it is said, will be based upon the priority of Swan as the inventor of the incandescent lamp. It will be held, according to rumor, that the consolidation of the Swan and Edison interests in England prior to the conclusion of the suit between them resulted in the merits of case being only partially developed there.



HAMMER'S EXHIBIT NO. 7.

Electrical Insurance Risks.

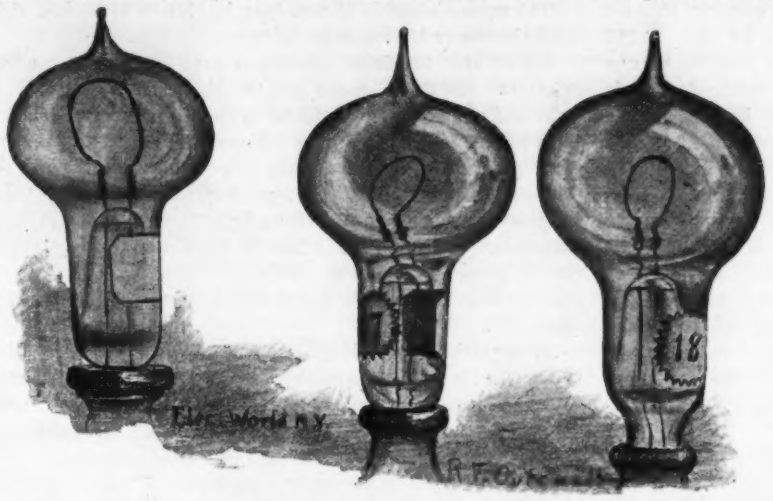
An interesting point is considered by Mr. F. W. Fairfield, city electrician of Nashville, Tenn., in a recent communication, which the discussion of insurance at the meeting of the National Electric Light Association prompted him to send. He states that the underwriters have always laid great stress upon the interior wiring of buildings and its thorough and careful inspection, which is unquestionably right and necessary. He adds, however, that the inspection of exterior wires is quite as essential if the least fire risk is to be attained The majority of fires which are attributed to electrical causes do not appear to result from interior wiring entirely, but from crosses and troubles in the outside wires, often a considerable distance away. It is to be noted that interior wires, after having been once placed and properly insulated, are likely to remain in that condition without disturbance; but in the case of exterior wires, they are constantly being changed, new circuits being added, old wires being taken down, and so forth. Moreover, telephone, telegraph, light and power wires will often be found using the same streets, sometimes the same poles, and frequently crossing and recrossing in close proximity to each other. It is evident that where changes are frequently made in these wires there is great danger of their being crossed or grounded, and even the telegraph and telephone wires, innocent enough in themselves, may be the means of carrying a current into some building which is ill prepared to receive it. The underwriters can hardly exercise any authority over the wires in the streets, or if they assume such it is with great difficulty enforced. The city authorities have exclusive supervision here, and their orders are alone likely to be obeyed. A continual inspection of exterior wires and the exercising of a general supervision of all construction work and changes, as well as the methods and means em-

ployed for making connections with buildings, the running of wires around cornices, placing guards over trolley wires, etc., would reduce to a great extent the danger of fires from electrical sources.

The Story of the Evolution of the Edison Incandescent Lamp.—II.

Hammer's Exhibit No. 6 shows four lamps which embody the following features: A rounded bulb with elongated neck, the inside part also rounded and hollow; and where the platinum leading-in wires are sealed onto the glass at the top of the inside part the glass is drawn up around the wires; the tips on the globe are somewhat pointed and hollow; the carbons are of the paper horseshoe type and are held by platinum clamps which are clearly shown. These lamps were made late in the year 1879 (November or December).

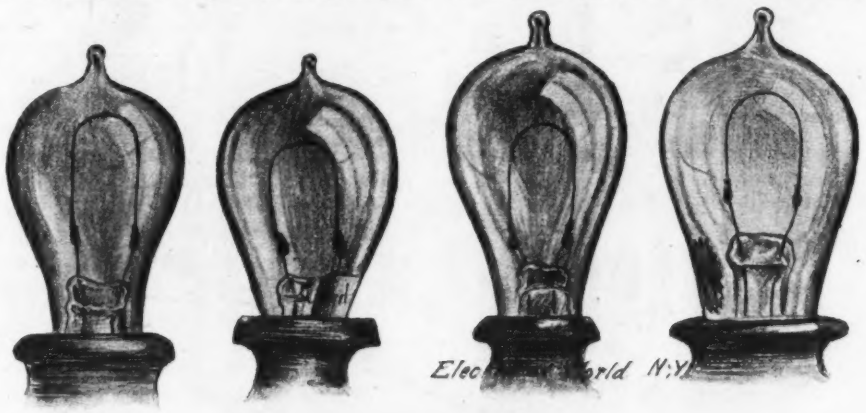
Hammer's Exhibit No. 7 shows similar lamps embodying several changes. It will be noted that the two lamps in the centre of the illustration are considerably larger than heretofore, and it was believed at that time that the lamps would last longer in a larger inclosing chamber. Note that the tops of the lamps have long supplemental tips of solid glass. It was believed at this time that air leaked into the globes at the point where the lamp was sealed, and it has been the practice up to within the past six or seven years to place these supplemental tips upon the globes. It must be noted that the sealing of the glass where the globe is joined onto the inside part is very roughly done in all of these early lamps, although the glassblowers who did this work were probably as skillful as any in the country at that time. These lamps were made very early in 1880.



HAMMER'S EXHIBIT NO. 8.

Hammer's Exhibit No. 8 shows the use of a soft white German glass at the top of the inside part to effect a more perfect seal where the platinum wires pass through the glass drawn up around the platinum wires, and the use of the white German glass has ceased. In Nos. 1, 2 and 3 the clamps are of nickel, and the difference between this clamp and the platinum clamp may readily be seen by comparing it with the clamps in No. 4. The sealing of the outside globe to the inside part is still very irregular, and is particularly noticeable in Nos. 2 and 4. These lamps were made early in the fall of 1880.

Hammer's Exhibit No. 10 shows a set of eight-candle lamps, or, as they were at that time called, "B" lamps, the filament being of bamboo, and one-half the length of 16-candle lamps. It will be noted that a standard form of globe has now been adopted; that the supplemental tips on the tops of the globes have been shortened and improved in appearance; that the inside part has been squeezed together while hot, so that the platinum leading-in wires pass through a large piece of solid glass. Lamp No. 2 shows a slightly different shape of clamp. This is made of silver; the others are of platinum. Particular attention is called to the butt of the lamp, which is made of wood, and into which the lamp is inserted. The wires leading from the lamp are soldered to contact rings insulated from each other, one plain and the other threaded, to facilitate making contact in the lamp socket. These lamps were made in the winter of 1880.

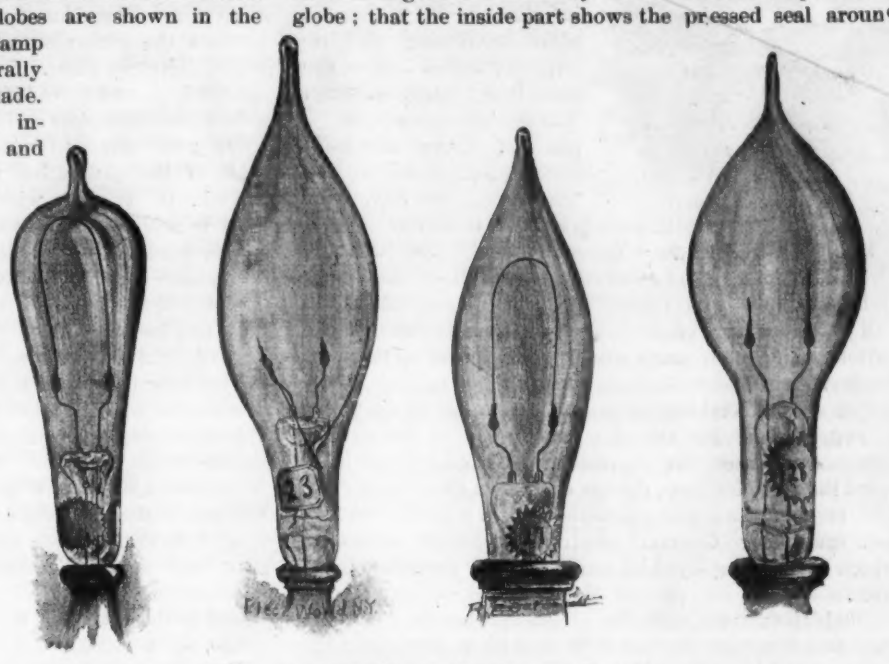


HAMMER'S EXHIBIT NO. 10.

Hammer's Exhibit No. 11 shows an experiment with silver-plated clamps. At this time experiments were being made with both silver and copper, to save the expense of the platinum clamps, which, up to that time, had been the standard, and also to make the contact between the platinum wires and the carbon filament better. The silver is plainly shown in lamp No. 1, and in the other three lamps in the illustration the silver has been volatilized and deposited upon the lamp globe. These lamps were made in January of 1881, save No. 1, which contained an eight-candle carbon, and which was made in April, 1881. The improvement in the glass seals of the lamp is noticeable in these lamps and all lamps made at this period.

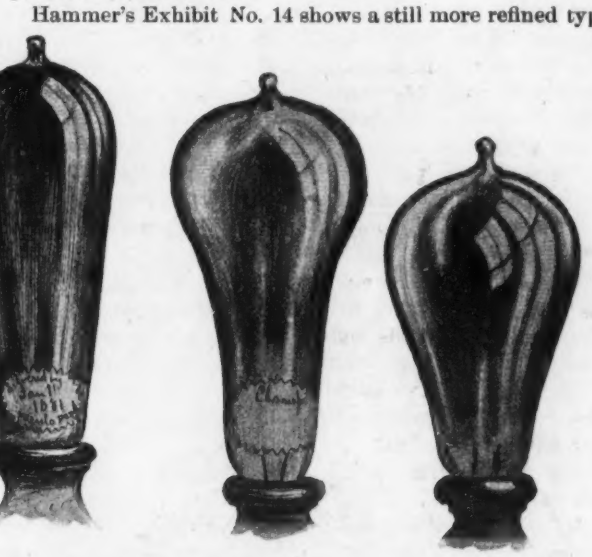
Hammer's Exhibit No. 12 shows two of the earliest copper plated lamps, and attention is called to the very thick deposit of copper around the shanks of the carbon and leading-in wires. The first lamp in the illustration was considered at that time a phenomenal lamp, as it was the first incandescent lamp which had made a long record, having lasted 1,589 hours at 16 candles. I remember the great interest which it attracted in the laboratory, and secured permission to keep this lamp when it gave out. The labels were placed upon it by me at that time. These lamps were made in the spring of 1881.

Hammer's Exhibit No. 13 shows a set of the standard copper-plated lamps. These lamps were adopted as the standard type in the spring of 1881, except the form of the base of these lamps which was adopted in the following fall or winter. It will be noted that the deposit on the lamps is much lighter than in the previous one; that there is a general uniformity in thesize and shape of th e globe; that the inside part shows the pressed seal around the leading-in wires; that the globe contains a high-resistance filament of carbonized bamboo; that the supplemental tips on the globes are of the same general character, and that the butts of the lamps are made of plaster of paris into which the globe is inserted while the plaster is soft, the copper wires being led to contact rings on the plaster stub, as shown.

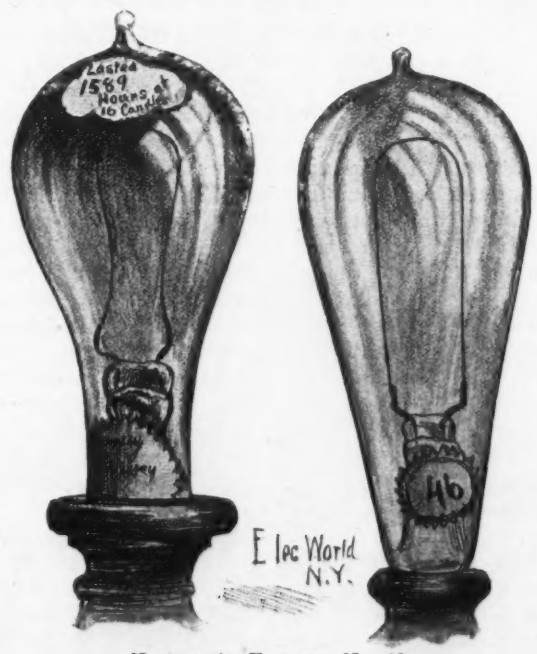


HAMMER'S EXHIBIT NO. 9.

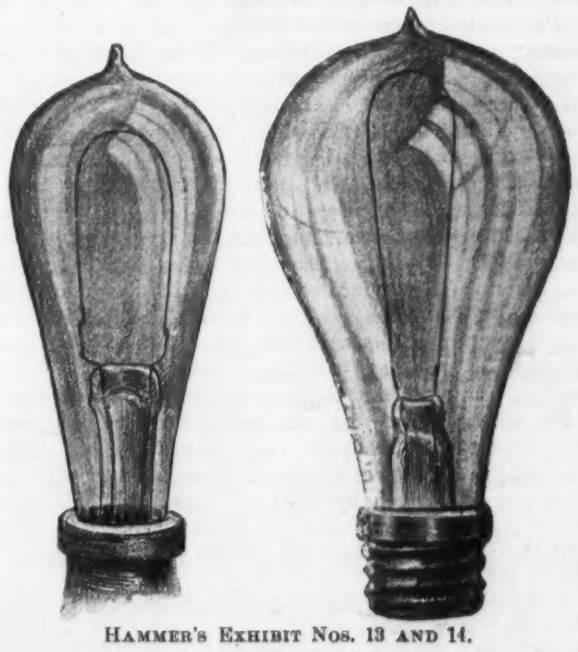
Hammer's Exhibit No. 14 shows a still more refined type of the Edison incandescent lamp and the most modern form. In the general characteristics it is the same as the lamp in Exhibit 13. The copper plating has been replaced by carbon paste, which has only come into extensive use within the past five years, the carbonized filament of bamboo is slightly finer, the supplemental tip on the lamp has been omitted, and the plaster butt on the bottom of the lamp has been made smaller, and the contact rings have given place to a brass contact plate at the bottom and the threaded brass ring, as shown in the illustration. As already stated, these lamps marked certain radical steps in the development of the Edison incandescent lamp. There are many features of minor importance and a thousand and one experiments have been tried, that have not been referred to herein.



HAMMER'S EXHIBIT NO. 11.



HAMMER'S EXHIBIT NO. 12.



HAMMER'S EXHIBITS NOS. 13 AND 14.

Electricity at the World's Fair.

THE ELECTRICAL PLANT IN MACHINERY HALL.

A VISIT to a plant in process of installation is oftentimes more interesting and instructive than a view of the same in the completed state. Where but one view is possible, that of the completed plant is by far the preferable, but a view of the plant in both conditions is preferable to either.

This week we will take a stroll through the immense electrical plant (the largest in the world) in Machinery Hall, and as we pass rapidly from the eastern end of the hall to the western, observe the state of completion of the various component parts which go to make up this vast display.

The seven Worthington pumps, in so far as they are to supply water for the electrical fountains, are already complete and ready for operation. Adjoining these is located the large 600-h. p. double expansion cross compound Ball engine. This is also completed, and will run two 175-kw. multipolar General Electric Company's dynamos, which will be employed to illuminate the electrical fountains.

The high pressure cylinder of this engine is 20 inches and the low pressure cylinder 36 inches in diameter; the engine will have a stroke of 18 inches, make 224 revolutions per minute, and weighs complete 72,000 pounds. This engine is especially interesting from the fact that it is probably the largest high speed engine in this country. It will be assisted in its especial fountain duty by a 200 h. p. Armington & Sims engine, which is but partially completed. This latter engine was built under the direction of the General Electric Company by the Southwark Foundry and Machine Company, of Philadelphia, and is triple expansion. It will drive two large multipolar generators direct, which have 12 poles each. The field pieces of these latter are on the ground but not yet put together. The shaft, which is common to both armatures, is also on the ground ready to be placed on its bearings, when the building up of the armatures will be commenced. In this engine the three cylinders are arranged, as electricians would say, in parallel, connecting with separate crank pins or cranks at an angle of 120 degrees with each other and connected between and balanced by two heavy iron discs.

The Eddy company has two multipolar (four pole) generators erected and ready for running and one of similar size and pattern not yet complete. These are located to the west and are driven by Dick & Church tandem compound engines not yet in running order. In the same block with the latter and to the south are two E. P. Allis engines, also as yet unfinished.

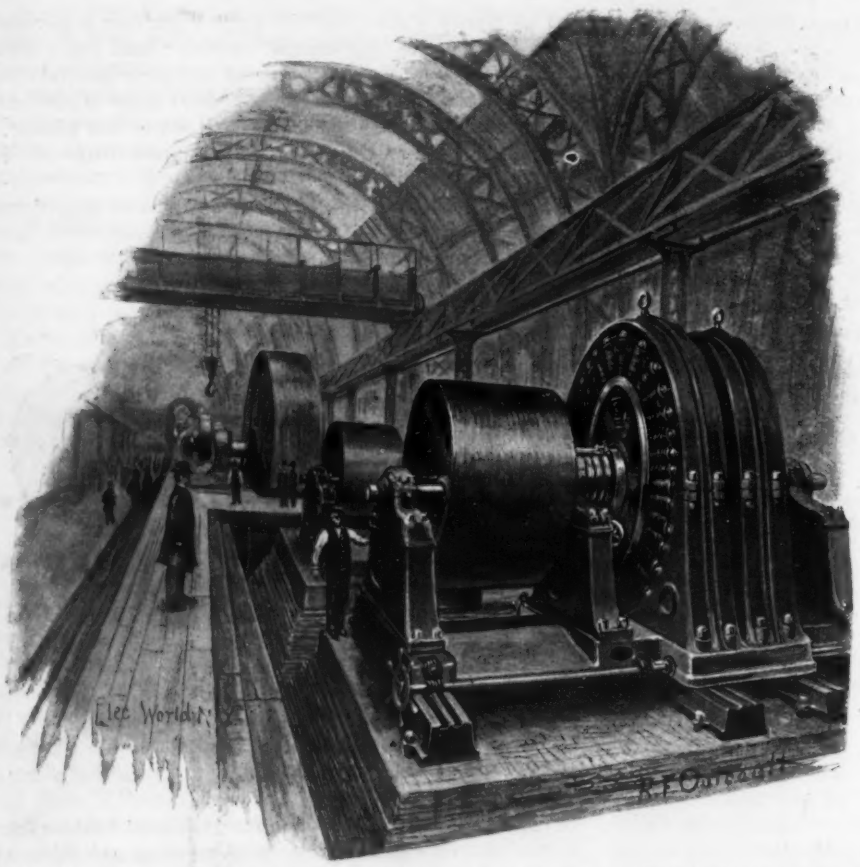
In the next block, on the aisle, the Stearns Manufacturing Company, of Erie, Pa., has erected a 600-h. p. tandem compound engine to drive two Mather generators not yet in place. To the south of this is another tandem compound engine of 400 h. p., driving two Mather 120-kw. generators. These latter are already in operation and doing service on the power circuit.

Adjoining these are two Springfield Ideal engines, each operating two large 500 volt C. & C. motors, also connected to the power circuit.

Next we come to a portion of the Brush exhibit occupying a block by itself. In this there are already 12 arc light machines of 60 lights each in operation. There will be 16 in all; but four, though on hand are not yet in working order. The Brush switchboard is a very neat and hand some piece of furniture, made of hard rubber, and stands between the generators and the Ball & Wood engines which drive the plant. Of these engines there are four—one 250 h. p. and three 200 h. p. This plant may be said to be almost complete and in operation.

We next come to what may be termed the central exhibit of the generating plant, viz., the great E. P. Allis 2,000-h. p. engine which drives two of the 10,000 light Westinghouse alternators in tandem. This enormous engine is now ready for the steam, and is worthy of a little of our time even in this cursory view of the building. The flywheel of this engine is 30 feet in diameter and 62 inches face, and looms up above everything else in the building at present. On this enormous flywheel will run two belts driving two of the great 10,000-light Westinghouse dynamos. The engine is of the triple expansion type having four cylinders—26, 40, 60 and 70 inches in diameter. The length of stroke will be 72 inches. To the south of the Allis engine is situated a 200-h. p. compound condensing engine of the McEwen make, of Ridgeway, Pa. This is now running two C. & C. 80 kw. 250-volt generators, which have for some time been supplying current for the elevators in the Administration Building.

Still to the south of this and in the same block is the Fraser & Chalmers 1,000-h. p. engine, still incomplete. This is also a triple expansion machine with four cylinders and is intended to run a single Westinghouse 10,000-light generator. The latter is nearly, but not quite, complete.



THE E. P. ALLIS 2,000-H. P. ENGINE AND 10,000-LIGHT WESTINGHOUSE DYNAMO.

In the immediate vicinity, but to the west, closed in at present by canvas walls, are two 250-h. p. Westinghouse compound engines, which have for some time past been driving two alternating current generators for lighting purposes in the Administration and Service buildings. These engines make 250 revolutions per minute at 125 pounds of steam, and are belted each to a separate generator.

South of this tent-like structure, occupying the very centre of the south wall of the Palace of Mechanic Arts, which, by the way, is the official title of Machinery Hall, reached by two galleries, is the magnificent switchboard by which are controlled all the numerous circuits from the Westinghouse dynamos used for incandescent lighting at the Exposition. This is by far the largest and most elaborate switchboard ever constructed in the world, and will doubtless share, with the 12 great generators which it controls, the chief interest of constructing engineers visiting this enormous exhibit.

There are really two switchboards, both constructed of white marble and arranged in tiers; the upper contains the switches controlling the exciter machines, which are four in number and are what are termed "direct connected kodak type" machines; these are wound for 250 volts and each has a capacity for 400 ampères. These four work in multiple and furnish current to excite the fields of the twelve 1,000-light and two 4,000-light alternators which constitute the Westinghouse lighting plant. This board is therefore known as the "exciter board" and is the standard Westinghouse railway switchboard. The other board is known as the dynamo board, and this is divided into 26 panels, all essentially alike, each of them controlling a separate generator. It will be remembered that each of the 10,000-light generators is really two machines, and each of these is capable of separate control. Each large generator, therefore, has two panels on this board, making 24, and the two 4,000-light machines each have a panel, making 26 panels.

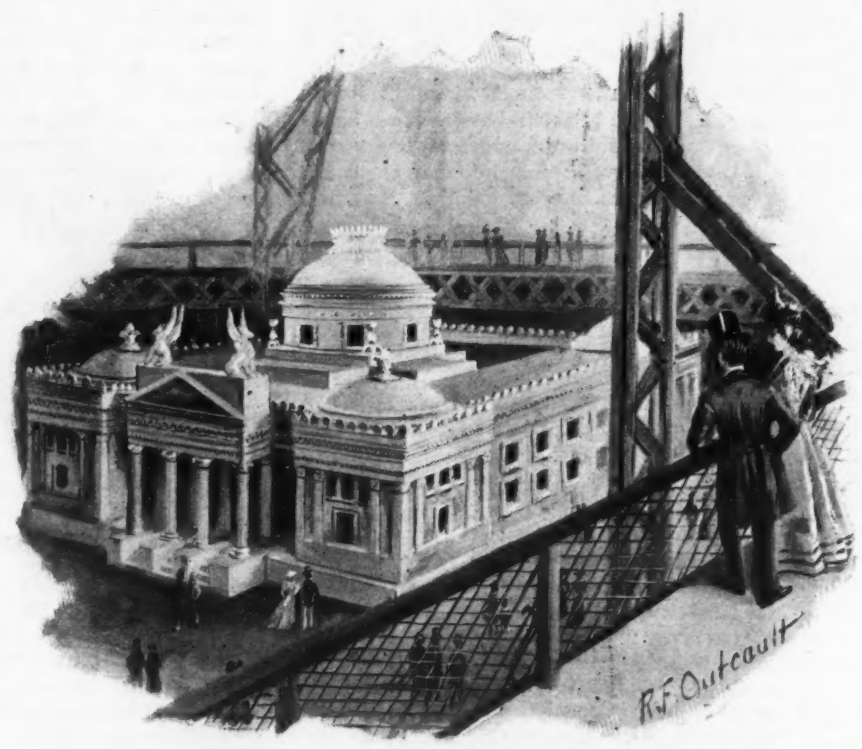
Each panel consists of two field rheostats, field switches, dynamo changing switch, voltmeter, ammeter and pilot lamp.

There are 40 feeders at present connected with this board, and each feeder is supplied with a voltmeter and ammeter, compensator, Stilwell regulator and pilot lamp, dynamo changing switch and plug panel; this equipment constitutes the feeder board.

The upper board is 71 feet long by 9 feet 3¼ inches high, and the lower is 38 feet by 11 feet 1¼ inches.

All of the 12 large machines are in this immediate vicinity. Of these, seven are, at this writing, ready to run and the remainder will be in the same condition before this article is on the press. Four of the 12 not yet referred to are to the west of the canvas tent and are each coupled direct to a 1,000-h. p. compound Westinghouse engine; another will be driven by a 1,000-h. p. McIntosh & Seymour engine and another by two Buckeye engines of 500 h. p each, coupled in parallel. These are all very near completion and will be ready for operation not later than April 22.

In regard to these large generators which have already been illustrated and partially described in THE ELECTRICAL WORLD, it may be said in addition that there are 72 poles on each machine—36 to each armature. The arrangement is such that the phases of the two armatures differ from each other by 90 degrees, and that there is a separate collector to each armature; thus each machine may send out two circuits. The switching arrangements are such that a simple alternating current for lighting purposes may be sent out, or two such currents differing in phase by 90 degrees may be supplied for Tesla two-phase motors, or two of the four wires of these two circuits may be combined, forming a three-wire system for Tesla three-phase motors.



THE EXHIBIT OF THE BELL TELEPHONE COMPANY.

In this exhibit, as well as throughout the buildings, may be seen the stopper lamp in full blaze, which not long ago on their first appearance excited such interest because of their supposed evasion of the Edison patent. While speaking of this lamp, it may be well to say that the statement of Mr. Seward in his argument before Judge Hallett, in St. Louis, recently, that "If the defendants (the Columbia Incandescent Lamp Company) think they can use iron or copper leading-in wires they are welcome to do so," would seem to set at rest, as far as his authority goes at least, all question as to their infringement of the Edison patent.

To the west of the Westinghouse incandescent lighting plant comes the Fort Wayne arc lighting installation, consisting of one 80-lighter, one 60-lighter, and fourteen 50-lighters, together with one 150-kw. 500-volt Fort Wayne generator. These are all ready to run, and will be driven by one 300-h. p. cross compound, one 250-h. p. tandem compound, one 150-h. p., and two 100-h. p. simple engines, all of the Buckeye make, no two alike.

Across the aisle to the west of this Buckeye engine plant are located the Standard arc dynamos. There are 20 of these, which will be run by four Russell engines. All of these, including the arc switchboard, are ready for use.

Still farther to the west, occupying separate blocks, are two groups of Thomson-Houston arc machines. In one of these there are 16 and in the other 10. These are in place, but the engines which will drive them are not yet erected.

The Western Electric Company, which has contracted to supply 500 arc lights, has its machines on hand, but none of them are erected.

The boiler plant which is to drive all but the last two installations, viz., that in the boiler house proper, is practically complete.

Thus it will be seen that the heart of the electrical exhibit—viz., that portion which is to supply the vital energy to all of the exhibits in the Electricity Building—is practically complete. We wrote of its condition on Wednesday, April 19. Almost everything that is incomplete now will be finished by Saturday, thus allowing a full week for testing previous to the inauguration, on May 1. Much has been said in the papers in regard to the incomplete condition of the Exposition. That it should be incomplete at the opening would seem to be inevitable, but as far as the electrical part is concerned there will be more than one can examine critically in a whole week's time completed and in running order the day the gates are open. Immense progress has already been made in the Electricity Building, and while the floors still look somewhat bare they are rapidly losing this appearance, and there will be much that will be attractive on the opening day.

A QUIET CORNER IN THE ELECTRICITY BUILDING.

ELECTRIC LAUNCHES AT THE WORLD'S COLUMBIAN EXPOSITION.

A novel means of transportation, and one that will prove a most attractive feature of the World's Columbian Exposition at Chicago this summer, will be the fleet of 50 electric launches, which will make regular trips over a course of about three miles on the lagoons and other interior waters at Jackson Park. The plan of water connection was first conceived by Mr. Frederick Law Olmsted, the landscape architect of the Exposition, and Gen. C. H. Barney, of New York, is undoubtedly the originator of the scheme to employ electric passenger launches. These boats will run from 8 a. m. until the fair closes at night, and the landings on the course will enable passengers to get on or off at any of the buildings and principal points of interest, thus rendering the launch fleet the best means of communication between different parts of the grounds, as well as the most delightful method of obtaining a general view of the magnificent buildings, which all front on the lagoons and canals.

As may be supposed, the competition for this valuable concession was very great. Several concerns were bidders for this exclusive privilege, and each of them was required to build a sample boat to be submitted to trial tests during the months of June and July last, to determine which class of craft was best suited to fulfill the requirements of passenger traffic on the Exposition waterways. Steam, naphtha, and electric launches were tested, with the result of success for the electric boat Electra, owned by the Electric Launch and Navigation Company, of New York, which concern was thereupon awarded the franchise.

The general dimensions of the boats to be used will be 35 feet 10 inches in length over all, with a beam of 6 feet 3 inches, a draft of 28 inches, and they will seat comfortably about 30 passengers each. The motive power will be furnished by storage batteries, manufactured by the Consolidated Electric Storage Company, and motors especially designed and constructed by the General Electric Company. Batteries and motor are placed beneath the seats and flooring, so that the utmost carrying capacity of the boats can be availed of; and they are absolutely free from smoke, grease, offensive odors and vibration.

Each boat in actual daily operation during the Fair will cover on an average 40 miles a day, with one charge. The total mileage per day for the 50 launches will therefore aggregate 2,000 miles, or more than from New York to Chicago and back each day.

A SCENE IN THE GERMAN SECTION.

The normal speed, all that is allowed by the World's Fair, is six miles per hour. A speed of eight miles per hour is, however, at the control of the pilot for emergencies.

The batteries used for supplying current to the motor are the latest and most improved form of the well known Consolidated Electric Storage Company.

The four-h. p. motor that is directly connected with the propeller shaft was especially designed by the General Electric Company for this purpose and has shown itself efficient and durable. The controller consists of magnetically controlled switches operated by a lever at the pilot's right hand. Four speeds ahead and two astern are found to satisfactorily answer all purposes.

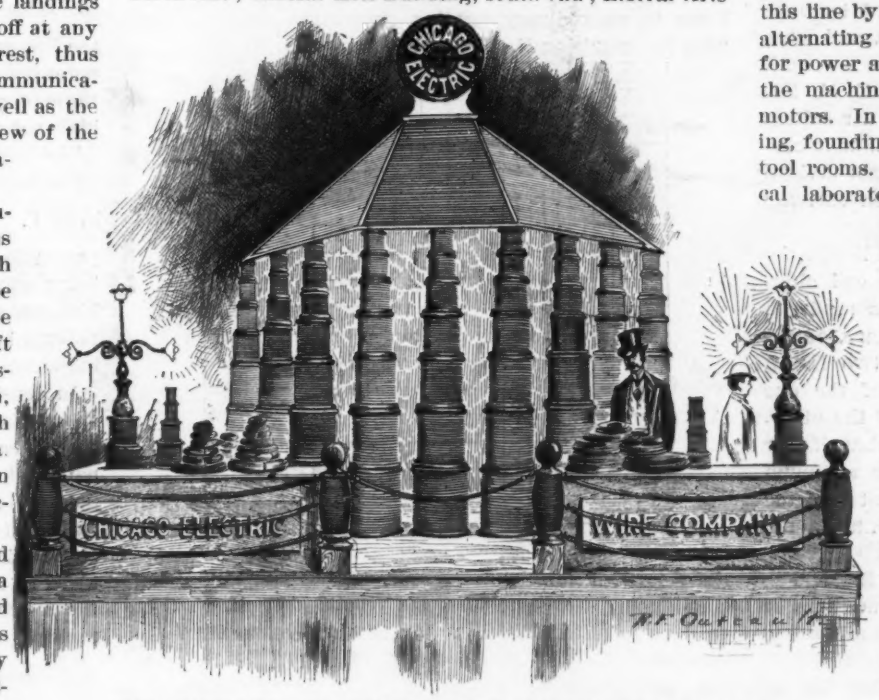
Should any batteries be injured by an accident they can be replaced in less than five minutes.

For the regular and moderate speeds required the batteries are first grouped in three divisions of 26 cells in series, giving a pressure of 52 volts, and, when operating, a discharge of 42 to 45 ampères, or 14 to 15 ampères per series. This grouping operates with and without a resistance in circuit as the pilot may manipulate the lever. The other grouping consists in putting the cells in each launch in two groups of 39 cells in series, giving a pressure of 78 volts and a discharge through the motor of about 55 ampères. This grouping also operates with and without a resistance. This method of grouping is used to prevent over discharging from the batteries and to give a steady and continuous current to the motor.

When a launch returns to its dock at the charging station from its 40 miles run it is connected with the charging circuit in less than one minute by an independent switchboard connected to feeders from large General Electric Company's dynamos in Machinery Hall. For the 10 to 12 hours' run a charge of five to seven hours at an average rate of 15 ampères will ordinarily recharge the batteries.

The course to be taken by the launches will be from the north side of the Agricultural Building, along the south side of the Manufactures Building, thence up the north canal through the east lagoon, turning into the north inlet past the Fisheries Building to the Clam-bake landing. Thence, back again through the inlet, and into the north lagoon, to the Fine Arts Building; from there returning, and down the west lagoon and north canal to the starting point.

The landings will be as follows: Agricultural Building, north side; Liberal Arts Building, south end; Liberal Arts Building, southwest corner; Liberal Arts Building, west centre; Government Building, north side; Fisheries Clam-bake, Illinois State Building, Woman's Building, Horticultural Building, Transportation Building, Mines and Mining Building, Electricity, northeast corner; Electricity, southeast corner.



THE CHICAGO ELECTRIC WIRE COMPANY'S EXHIBIT

The round trip will occupy about 52 minutes, and the fare for the same will be 50 cents.

The officers of the company are: President, Henry Steers; vice-president, E. J. Moore; secretary and treasurer, Alfred Skitt.

The officers in immediate charge of the operation of the concession on the grounds are: General manager, C. D. Wyman; superintendent, C. H. Barney; electrical engineer, R. N. Chamberlain.

For the use of its principal officials, the Exposition has purchased four of these boats, similar to the above, but with decks and interior more highly finished, and different colored awnings. One of these boats will be appropriated to the use of Chief of Construction D. H. Burnham, another to Director-General Geo. R. Davis' convenience, and the other two will be assigned to the Council of Administration, of which Mr. H. N. Higinbotham is the head.

The uniform of the employees will be: For pilots, dark blue suit, double-breasted coat, navy style cap, with word "Pilot" on cap; for guards, both on boats and landings, similar dress, except coat to be single breasted, and word "Guard" on cap; for ticket men, same, except word "Ticket Agent" on cap.

The boats will be carpeted with perforated rubber mats, with a solid canvas backing to catch all dirt and water. The cushions are of leather, stuffed with hair. The awnings and side curtains are striped orange and black, of pattern and color selected by E. D. Millett, Director of Colors.

The boat shed and charging station will occupy the east and south sides of the Agricultural Annex, some 700 feet in all.

A few of the numerous advantages of electric launches over those using coal, gas or oil may be stated as follows Absolute freedom from smoke, gas, odor, heat, ashes, cinders, dirt, grease and other things of the kind that greatly mar the pleasure of passengers in previous styles of launch without electricity; freedom from noise, whether from gear-wheels, exhaust or other sources; motor armature directly coupled to the propeller shaft; no jerking or jarring, the only motion being smoothly rotary, not reciprocal; simplicity; no government inspection and no licensed engineer or any crew at all required; the management is so simple that ladies and children operate the boats with ease; absolute safety, no danger of explosion; availability—the only launch which has its power always ready for immediate use; greater stability than any other launches, from the fact that the weight of motive power is beneath the flooring; great carrying capacity, the motor being under the floor, batteries under the seats, and the entire boat space free for passengers.

In the accompanying illustrations two of the most attractive exhibits in the Electricity Building are shown, that of the Bell Telephone Company and that of the Chicago Electric Wire Company, both of which were briefly described in the last issue of The Electrical World.

Armour Institute.

With the University, and Mr. P. D. Armour's latest gift, the Armour Institute, Chicago seems destined to become devoted to scientific as well as commercial enterprises.

The building, pleasantly situated in the residence portion of the city, is of brownstone and brick, and the interior finished in white marble. The power plant is nearly completed, and consists of two Stirling water tube boilers and a 200-h. p. Hamilton-Corliss engine, which is to be run either condensing or non-condensing. Rope transmission will be used to connect the engine with the line of countershafting. Four dynamos will be attached to this line by friction clutches. The dynamos will be both alternating and direct. Two will be used for lighting, one for power and the fourth for experimental purposes. All the machinery in the laboratories will be operated by motors. In the basement there are rooms for wood working, founding, forging and drafting, and several store and tool rooms. On the first floor there will be a mechanical laboratory and a machine shop, the office of the president and the general library. The second floor is devoted to the departments of electricity, chemistry and physics, each with ample laboratories and lecture rooms. There will be fourteen more or less distinct departments, but the aim of the institute is to become a technical school of the highest grade. The technical course will be in mechanical and electrical engineering, physics and chemistry. Each laboratory will be provided with a complete technical library, and, in addition, there will be a general library of literary, historical and scientific works. The institute will be opened in September next.

The appointment of the scientific faculty are: Victor C. Alderson, of Chicago, professor of mathematics; James C. Foye, of Lawrence University, professor of chemistry; Wilbur M. Stine, of the Ohio University, professor of electrical engineering; W. H. Runyon, of the Chicago University, instructor in physics; E. W. Cooke, of Chicago, director of school of mechanical engineering.

Moonlight Table for May, 1893.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of May, under his modified form of moonlight schedule:

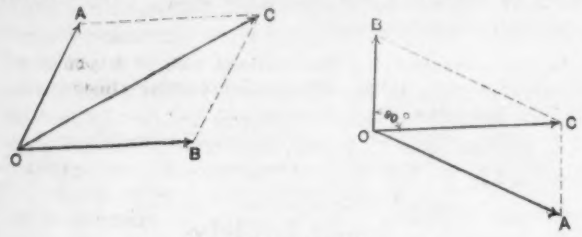
TABLE NO. 1. Standard Moonlight. Philadelphia System.				TABLE NO. 2. Frund's New Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7:30 P. M.	1	9:00 P. M.	1	7:30 P. M.	1	9:00 P.M.
2	7:30	2	10:00	2	7:30	2	10:00
3	7:30	3	10:50	3	7:30	3	10:50
4	7:30	4	11:50	4	7:30	4	11:50
5	7:30	6	12:10 A. M.	5	7:30	6	12:10 A.M.
6	7:30	7	1:20	6	7:30	7	1:20
7	7:30	8	2:10	7	7:30	8	2:10
8	7:30	9	2:40	8	7:30	9	2:40
9	7:30	10	3:10	9	7:30	10	3:10
10	7:30	11	3:30	10	7:30	11	3:30
11	7:30	12	3:50	11	7:30	12	3:50
12	7:40	13	3:50	12	7:40	13	3:50
13	7:40	14	3:40	13	7:40	14	3:50
14	7:40	15	3:40	14	7:40	15	3:40
15	7:40	16	3:40	15	7:40	16	3:40
16	7:40	17	3:40	16	7:40	17	3:40
17	8:10	18	3:40	17	7:40	18	3:40
18	9:50	19	3:40	18	7:40	19	3:40
19	10:50	20	3:40	19	7:40	20	3:40
20	11:50	21	3:40	20	7:40	21	3:40
21				21	7:40	22	3:40
22	12:10 A. M.	22	3:40	22	7:50	22	12:00 M.
23	12:30	23	3:40	23	12:30 A. M.	23	3:40A.M.
24	12:50	24	3:40	23	7:50 P. M.	23	12:00 M.
25	1:10	25	3:40	24	12:50 A. M.	24	3:40A.M.
26	1:30	26	3:40	24	7:50 P. M.	24	12:00 M.
27	1:50	27	3:40	25	1:10 A. M.	25	3:40A.M.
28	No light.	28	No light.	25	7:50 P. M.	25	12:00 M.
29	No light.	29	No light.	26	1:10 A. M.	26	3:40A.M.
30	No light.	30	No light.	26	7:50 P. M.	26	12:00 M.
31	7:50 P. M.	31	9:50 P. M.	27	7:50	27	12:00
				28	7:50	28	12:00
				29	7:50	29	12:00
				30	7:50	30	12:00
				31	7:50	31	12:00
Total hours lighting, 140.20.				Total hours.			

Capacity and Self-Induction in High Potential Circuits.

BY CHAS. PROTEUS STEINMETZ.

Ten years ago electric lighting was in a remarkable condition; the alternating current dynamo, which in the earliest time of electric lighting had ruled unrestrictedly, had left the field to the continuous current dynamo and the arc lamp; the incandescent lamp was being introduced, and the alternating dynamo soon expected to be seen only in museums of ancient history.

The introduction of the alternating current transformer suddenly changed the whole aspect. In long distance incandescent lighting the alternator found an application where the continuous current dynamo was out of question, and even where both currents came into competition, the alternate current, due to the ease of its trans-



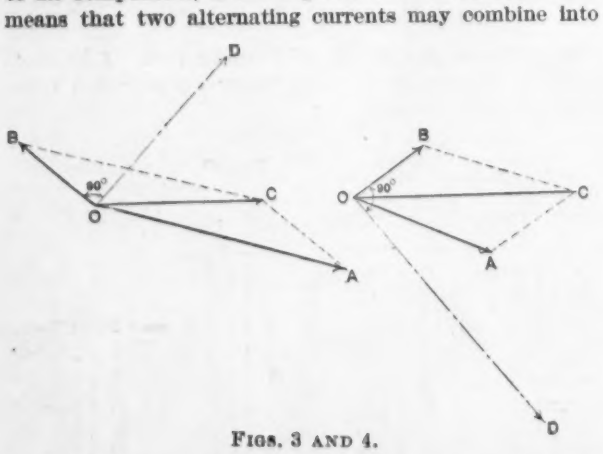
FIGS. 1 AND 2.

formation, frequently carried the day. Only in the field of arc lighting the continuous current has still maintained a superiority, due to the early development of the high potential continuous current arc light system.

With the rapid spread of the alternate current system, phenomena became noticeable which had no analogy in continuous current circuits. Ohm's well established law seemed not to hold any more for alternating currents. Sometimes the current flowing was far below the value expected from the resistance of the circuit. E. M. Fs. were consumed in circuits far in excess of the product of current and resistance. Amperes multiplied by volts did not give the watts, the energy, any more, and large "wattless" currents flowed into circuits where no work worth speaking of was being done. Several E. M. Fs., acting upon the same circuit, gave, combined, a resulting E. M. F. not equal to the sum of the E. M. Fs., as in continuous current circuits, but less, and currents divided into branches, so that the sum of the branch currents was larger than the undivided currents.

In part, the explanation of these phenomena lies in the nature of the alternating current. What we call alternating current, or alternating E. M. F., is in reality a mean value, the square root of the mean square, of the ever-varying instantaneous values. If now two E. M. Fs. so combine that the maximum values of the one coincide in time with the maximum values of the other, the resultant E. M. F. is evidently larger than if the maximum values of the one coincide with the minimum value of the other, and vice versa. In the first case the resultant is equal to the sum of the components; in the second case, it is far less.

Hence, in combining alternating currents, E. M. Fs., etc., they have not to be combined by single addition or subtraction, but their difference of phase has to be taken into consideration; that is, they have to be combined by the law of parallelogram; that is, representing the E. M. Fs., currents, etc., in their magnitude and phase by two lines, O A and O B (Fig. 1), their resultant, is the diagonal O C of the parallelogram, with O A and O B as sides. Evidently, the diagonal O C is smaller than the sum O A + O B, and may be even smaller than either of the components, if the angle A O B is obtuse. That means that two alternating currents may combine into



FIGS. 3 AND 4.

a resultant current which is smaller than either of the two currents, or a current of, say, 20 amperes may divide into two branch currents of 30 amperes each.

E. M. Fs. differing in phase from the impressed E. M. F. are called into play by the self-induction of alternating current circuits. The alternating current produces an alternating magnetic field around the wires, which induces E. M. Fs. therein. These self-induced E. M. Fs. O B, combine with the impressed E. M. F. O A to form the resulting E. M. F. O C, which produces the current.

Now the self-induced E. M. F. O B is 90 degrees behind the current in phase, hence 90 degrees behind the resultant E. M. F. O C, and, consequently, the angle A O B is obtuse; that is, O C less than O A. That means self-induction decreases the E. M. F. and causes the current to lag behind the impressed E. M. F. by an angle A O C.

So the self-induction, long known to the telegraphers as "time constant," which made the relays kick and work sluggishly, appeared in the alternating current circuits as a potential consumer and lag producer. Taking these counter E. M. Fs. of self-induction into account, Ohm's law reigns supreme in alternating current circuits also.

Hardly were these phenomena of self-induction understood when a new puzzle appeared. In the Ferranti mains, concentric cables working under 10,000 volts pressure, instead of the expected drop of potential, a rise of potential was noticed, so that the potential at the receiving end was higher than at the generator end of the circuit. Still more marked, though less discussed, was this phenomenon in the Frankfurt-Lauffen transmission of 300 h. p. over 116 miles at 20,000 volts. There, when running under light load or no load, in the low potential feeders between dynamo and step-up transformer, a rise of potential appeared, so that the E. M. F. was lowest at the dynamo terminals, and when going along the feeders from the dynamo generator to the step-up transformer, the difference of potential steadily increased, and was highest at the terminals of the step-up transformer. In this case the ratio of transformation of the converter was larger than the ratio of turns. That means, when there were 50 volts at the dynamo terminals, at the primary terminals of the step-up transformers the potential was already 55 volts, and at the secondary terminals it was greater than 55 times the ratio of turns.

The explanation of this phenomenon is very simple. We have seen, in Fig. 2, that the E. M. F. O B, induced by self-induction in the circuit, combined with the impressed E. M. F. O A to form the resulting E. M. F. O C. The self-induction O B lags 90 degrees behind the current. Since in an ordinary lighting circuit the current flows with the resulting E. M. F., that is, the E. M. F. O C at

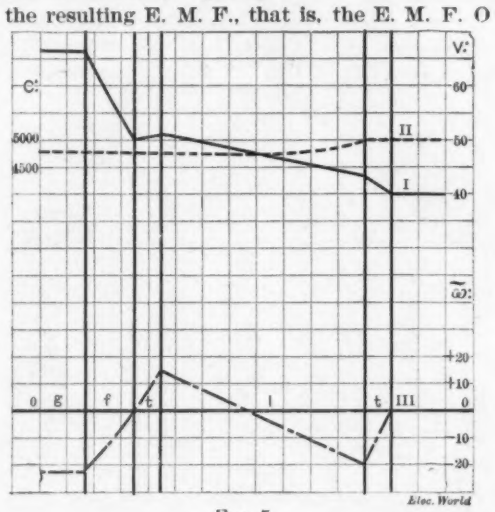


FIG. 5.

the consumer terminals, in this case the self-induction O B lags 90 degrees behind the resulting E. M. F. O C, and the resulting E. M. F. O C is slightly less than the impressed E. M. F. O A—the E. M. F. of generator in our case.

If, however, the current O D (Fig. 3) lags behind the resulting E. M. F. O C, as, for instance, in a motor circuit, the self-induction O B, being 90 degrees behind the current O D, makes an obtuse angle with the resulting E. M. F. O C. Completing this parallelogram, we see that the resulting E. M. F. O C is greatly less than the impressed E. M. F. O A. This is the explanation of the well known fact that on an inductive load the potential drops off greatly, due to the self-induction of the feeders and transformers.

If, however, by some means the current O D is made to be in advance of the resultant E. M. F. O C, the self-induction O B makes a sharp angle with the resulting E. M. F. O C. Hence, completing now the parallelogram O B C A, we see that the resultant E. M. F. O C is larger than the impressed E. M. F. O A; or, in other words, if O A is the E. M. F. at the dynamo terminals, and O B the self-induction of the feeders, the potential rises in the feeders, due to self-induction, and reaches at the end of the feeders, or the primary terminals of the step-up transformers, the value O C.

This phenomenon, rise of potential due to self-induction, takes place if the current is ahead of the E. M. F. in phase.

A condenser in an alternating current circuit consumes a current which is practically 90 degrees ahead of the E. M. F. at the condenser terminals. Hence, connecting a condenser in parallel to an alternating current circuit, the advanced condenser current, in combining with the current in the other part of the alternating current circuit, will give a resulting current, which is more or less in advance of the current in the consumer circuit, and is, consequently, if the lag in the consumer circuit is not excessive, in advance of the E. M. F.; and if this is the case, the self-induction in the part of the circuit between generator and branching points will cause a rise of potential, as Fig. 4 shows.

On the other hand, if the current in the consumer circuit has a considerable lag, the angle of phase between the condenser current and the current in the consumer circuit will be obtuse, and the resulting current less than either of the branch currents; that is, a small current supplied by the dynamo will, after a large condenser current has branched off, leave a large current for the consumer circuit. It need not be remarked here that the difference of phase between current and E. M. F. is less in the resulting current than in either of the branch currents, since otherwise this phenomenon would contradict the law of the conservation of energy.

Now, a long distance line has a considerable capacity,

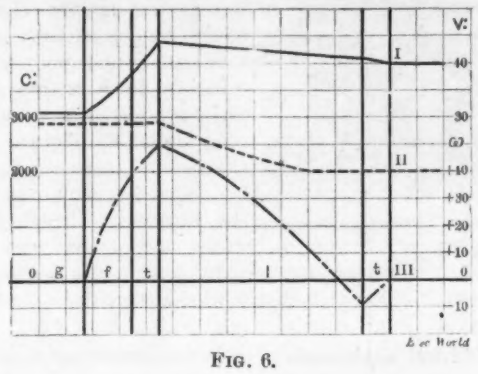


FIG. 6.

and therefore acts as a condenser connected in parallel to the main circuit, and consumes a charging current 90 degrees ahead of the E. M. F., which charging current, in combining with the main current, advances the phase of the current, and thereby gives rise to the before-described phenomena.

The charging or condenser current (or "wattless" current) of the line is proportional to the E. M. F. The main current necessary to transmit a given amount of power is inversely proportional to the E. M. F. Hence the ratio $\frac{\text{condenser current}}{\text{main current}}$, and therefore the effect of the line capacity, is proportional to the square of the line potential, and also to the frequency. This explains why these capacity effects become noticeable only at very high potentials.

The self-induction is proportional to the current. The current, at a given power, is inversely proportional to the E. M. F. Hence the ratio $\frac{\text{self-induction}}{\text{impressed E. M. F.}}$ is inversely proportional to the square of E. M. F.—other conditions being equal. Hence, in a given power transmission, the high potential line will be the seat of capacity, the low potential feeders and the transformers the seat of self-induction.

In considering the phenomena in such a complex circuit, it is preferable to bring all the parts of the circuit to the same condition, for instance, to the generator potential, by reducing the electric quantities in the high potential line and the consumer circuit by means of the ratio of turns of the interposed transformers. So, for instance, if the step-up transformers have the ratio of turns of 1 : 500, the step-down transformers the ratio of turns 400 : 1, we will divide all the line E. M. Fs. and multiply the line currents by 500, the consumer E. M. F. and currents by $\frac{500}{400}$, divide the line resistances and inductance, and multiply the capacities by $500^2 = 25{,}000$, etc., to reduce them to the conditions of the generator, and are enabled then to represent the whole circuit in a continuous diagram with the resistance as abscissae.

Let us, as an instance, consider a case similar to the Frankfort-Lauffen plant, that is, a transmission of 200 kilowatts at 25,000 volts and 50 periods over a distance of 50 miles. Step-up transformers may have the ratio of turns 1 : 500. The circuit will consist of, 60 feet primary

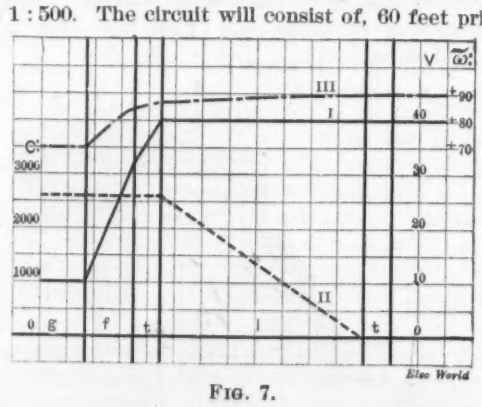


FIG. 7.

feeders, from dynamo to step-up transformer, of 2 inches diameter and 24 inches apart, having a resistance of R = .00036 ohm. and an ohmic inductance of .0084 ohm.* The step-up transformers have a resistance of .0002 ohm, and an inductance of .003 ohm.

The line has a resistance of 375 ohms, an inductance of 75 ohms, and a capacity of 1 microfarad. Hence, reduced to the generator potential, the line resistance is 0015 ohm. the inductance .0003 ohm. and the capacity nductance = — .0158 ohm. The step-down transformers

*As "ohmic inductance" I call the quantity $2\pi nL$, which is of the dimensions "resistance;" it can be expressed in ohms, and has the direct physical meaning, $\frac{\text{E. M. F. induced}}{\text{current}}$; hence is of more convenient for practical use than the henry.

have, again, the resistance .0002 ohm. inductance .008 ohm.

From this, by combining for the different parts of the circuit the E. M. F. impressed, consumed by resistance and inductance, and by combining the main current and the capacity current in their proper places by the law of parallelogram, the electric circuit diagram is easily derived, and is given in Figs. 5 to 8, for a constant potential of 40 volts at the receiving end; that is,

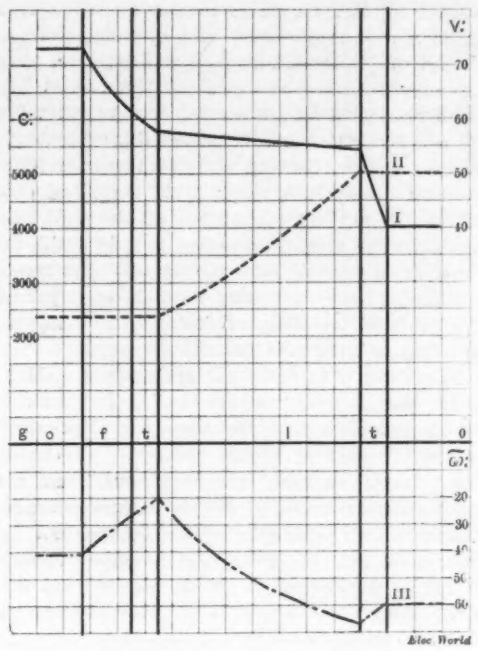


FIG. 8.

at the secondary terminals of the step-down transformer, and for the different conditons:

Fig. 5. non-inductive load of 5,000 amperes.
" 6. " " " " 2,000 "
" 7 open circuit (no load)
" 8 inductive load of 5,000 amperes and of 60 degrees lag (50% plant efficiency).

I. denotes the E. M. F., II. the current, and III. the difference of phase between the current and E. M. F. at the different parts of the circuit.

At a non-inductive load, Fig. 5, the E. M. F. drops considerably in the low potential feeders, rises in the transformer, drops again in the line and still more in the transformer. The current in the line first decreases slightly, then increases, and, though the line consumes a charging current of about 3,000 amperes, still 210 amperes more come out of the line than are sent into it. The curve III. gives the reason, showing the current ahead of the E. M. F. in the first transformer and the first part of the line, producing the rise of potential in the transformer, the decrease of current in the line. In the dynamo, the low tension feeders, the last part of the line and the second transformer, the current lags behind the E. M. F., and hence self-induction causes the potential to drop, but capacity the current to rise. The dynamo has to produce 66.25 volts to get 40 volts to the receiving end.

Very different are the conditions at a light load, of 2,000 amperes (Fig. 6). At 31 volts the dynamo sends 2,900 amperes into the circuit, and 2,000 amperes at 40 volts come out at the other end. The potential rises from 31 volts at the dynamo up to 44 volts at the secondary of the first transformer, and then slowly decreases; the current decreases in the first part of the line, and remains almost stationary in the last. The current is in advance of the E. M. F. everywhere, except at the end of the line and in the second transformer, and has no lag in the dynamo and receiving circuit.

In Fig. 7, on open circuit, or no load, 10 volts at the dynamo terminals are sufficient to maintain 40 volts at the end of the circuit; that is, the combined action of self-induction and capacity has increased the impressed E. M. F. fourfold, so that, passing from the dynamo along the low tension feeders, for every 32 inches we go away from the dynamo the E. M. F. rises 1 volt; 2,600 amperes disappear in the line. The whole way through the current is almost 90 degrees in advance of the E. M. F.

If now, for instance, by the gathering of moisture on the insulators, the capacity of the line should rise to a capacity inductance of —.012 ohms, 4.7 volts at the dynamo would be sufficient to maintain 40 volts at the other end of the circuit, and 3,400 amperes, leaving the dynamo at practically no lag, would disappear in the line.

Just the opposite takes place when feeding into an inductive circuit at the receiving end of the line (Fig. 8). The current lags more or less behind the E. M. F. in the whole circuit, the E. M. F. drops greatly, from 73 volts to 40 volts, but 2,380 amperes sent into the line by the generator come out as 5,000 amperes at the receiving end, and still the line "consumes" a charging current of about 3,550 amperes.

It will be interesting to note what takes place if the E. M. F. is kept constant at the dynamo terminal, at, say, 60 volts (Fig. 9).

Short circuiting the secondary of the stepdown transformer, 4,100 amperes will flow through the circuit, representing 38 kilowatts at the dynamo. The highest potential in the line is 6,950 volts.

Loading the receiving circuit by an inductive load of 60 degrees lag, and .008 ohms impedance, will not change the current, but still 4,100 amperes at 32.8 volts will arrive, representing 67 kilowatts. The dynamo, however, will produce only 1,940 amperes, representing 88 kilowatts. The highest line potential is now 23,650 volts.

At a non-inductive load of .008 ohm, 4,540 amperes at 36.3 volts will arrive, equal to 165 kilowatts; 4,350 amperes, equal to 242 kilowatts, will be sent out by the dynamo. The highest line potential is 23,150.

At a non-inductive load of .020 ohm, 3,870 amperes arrive at 77.4 volts—more than the dynamo potential—equal to 299 kilowatts; 5,600 amperes, equal to 336 kilowatts, leave the dynamo; the line potential, however, rises far beyond the normal, to 42,500 volts, and most likely something breaks down.

On open circuit, however, 15,600 amperes would leave the dynamo to disappear in the line, and not a wattless current either, but a current representing 320 kilowatts. Since, however, in this case, constant potential of 60 volts at the dynamo terminals, and open circuit at the receiving station, the line potential rises to 120,000 volts, this means certain destruction.

A slight increase of the line capacity can, if the line insulation would stand it, bring the line potential up to 260,000 volts, nine times the value calculated by the ratio of the transformation. However, even if the line could stand this potential, the dynamo could not give the power to produce the required "wattless" current of 43,500 amperes and 2,500 kilowatts.

Hence we see that in this circuit, at constant E. M. F. at the dynamo terminals and a transformer ratio 1÷500, the line potential can assume any value between 7,000 volts and practically infinite, and while short-circuited is harmless, but open circuit at the receiving end means certain destruction.

It must be understood, however, that the present case represents an extreme condition—transmission of comparatively small power over very great distance, at extremely high line potential and low generator potential. Usually, if we have to deal with larger powers, shorter

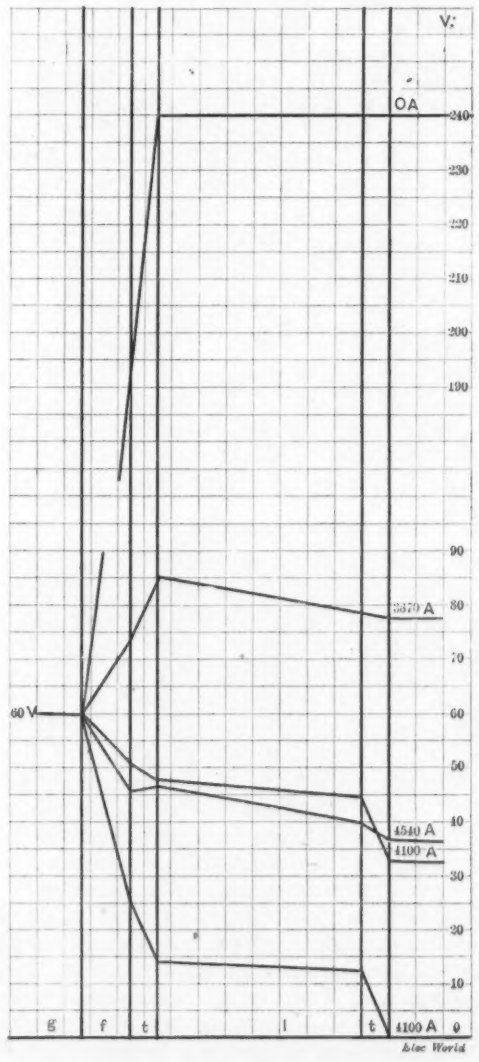


FIG. 9.

distances, lower line potentials and higher generator potentials, the capacity-self-induction effect will be very much less marked.

Safety Fuses versus Magnetic Cut-Outs in Electric Railway Work.

BY W. E. HARRINGTON.

The sole object of this article is to bring into prominence one of the most objectionable and vexatious troubles incident to the practical operation of an electric railway, and to give a solution, which has proved uniformly successful after 18 months' trial.

The relative merits of fuses and magnetic cut-outs, the two methods of protection of electric circuits, have not received the attention their importance demands. Fuses, either of tin or an alloy of tin and lead, inserted in the circuit to be protected, have been employed almost exclusively in electrical work, until recently, when the conditions of electric railway and certain cases of power transmission have demanded a quick, positive acting cut-out; this condition the magnetic cut-out complies with.

There is no question as to the utility and need of the fuse cut-outs in cases where steady loads are the conditions, and in circuits where the size of the fuse is but a small percentage of the size of the main fuse controlling this minor circuit. For an illustration we can assume the simple case of a 500-light 16 c. p. dynamo. The size of the main fuse or the adjustment of the magnetic cut-out would be for, say, 375 to 400 amperes, and as the practice is not to have on an average of more than 6 to 8 lamps on a circuit or fuse, 5 to 6 ampere fuses would be required, so that in case of any trouble on any of the small circuits the fuse on that circuit will invariably blow without affecting the dynamo fuses or open the main magnetic cut-out.

When the first electric railway plants were installed, the above practice in fusing was carried out, particularly as regards placing fuses in the power station to protect the generators, but trouble was experienced at the very outset. The capacity of the car circuits often approached so nearly the full capacity of the main circuits carrying them, that in case of any trouble causing abnormal flow of current, the whole system would be affected. The time required to melt the fuses and often the poor quality of fuses (for this class of work), allowing momentarily excessively large currents to flow through them, would in many instances throw the belts off the pulleys of the generators. The writer experienced this trouble repeatedly only four years ago, while in charge of a Sprague system. We overcame the matter by obtaining a magnetic cut-out from the old Daft company, paying $80 for it, the Sprague company not making such a device. Our troubles with the belts ceased upon placing the cut-out in circuit. Another trouble, however, continued which was in many respects more bothersome and difficult to remedy, and due to local trouble of some particular car as a ground or short circuit—I do not mean a heavy load—when the magnetic cut-out at the power station would invariably act although the cars had fuses on them, and the particular car causing the trouble would have to be found and removed from the circuit before the line could again be operated. Since the fuses on the cars could not be depended on to act they were neglected, and in a majority of instances copper wire was inserted in place of the regular fuse metal without any difference in the behavior of the cars. We experimented with smaller fuses, but owing to the occasional large jumps in the current we found a small capacity fuse would open the car circuit too frequently, while a fuse of larger capacity and really adapted to the motor was found inadequate to protect the motor circuit from the occasional grounds and short circuits. This has been the writer's experience with five electric railways, and his personal observation covering about a dozen more, where copper wire was used instead of fuse metal in the fuse boxes provided in the cars for that purpose.

The pith of the situation can be summed up as follows: Fuses in the motor circuits of street cars will not act when grounds and short circuits occur, because the fuse metal will pass currents for a short period of time far in excess of its rated blowing capacity; for instance, a fuse which will blow on, say, 50 amperes, will on a short circuit allow anywhere from 100 to 500 amperes to momentarily pass, this quantity being sufficient in the majority of instances to open the magnetic cut-out at the power station. At this point it is necessary to clearly define what constitutes the difference between a fuse cut-out and a magnetic cut-out; a magnetic cut-out will practically open the circuit when the current flowing through that circuit reaches the point for which the cut-out is set, whereas a fuse will pass an indefinite amount of current on a short circuit before fusing, owing to a variable time element involved. It is this defect that renders fuse metal valueless for electric railway motor work, as the work done is of a decidedly fluctuating character.

It has been urged as objections to the use of magnetic cut-outs for electric railway motor work that they are too sensitive, that they open the motor circuits on the overload the motors are expected at times to be able to carry, and that they are too expensive and not adapted by their construction for rough usage. In reply to these seeming objections the first objection as to sensitiveness is not tenable, as it is this sensitive quality which is desired. As to the cut-out opening on the overload the motor is expected to carry at times, the point at which the cut-out will open is purely a matter of adjustment and the writer always adjusts the cut-out to carry a current far in excess of the maximum current the motor would carry; about 30 per cent. in excess usually complies with all practical conditions. As to the third objection in regard to cost and construction, magnetic cut-outs are but slightly more expensive than fuse boxes used for the same purpose. The writer has invented a magnetic cut-out which is adapted for railway motor work, which he has found to meet the requirements of actual practice.

THE ELECTRICAL WORLD'S DIGEST

OF

CURRENT TECHNICAL ELECTRICAL LITERATURE.

(Compiled from the principal foreign electrical journals.)

BY CARL HERING.

ELECTRO-PHYSICS.

Rapid and Intense Heating Effect.—Messrs. Lagrange and Hoho, before the French Academy of Sciences, showed the results of some experiments based on the following phenomena which have been observed by a number of physicists: In an electrolytic bath the negative electrode is a metallic wire of small surface, and the positive electrode a conducting plate of large surface; when a current is passed, a luminous sheath is formed around the negative electrode. In their experiments they find that the larger part of the electric energy in the circuit is converted into light and heat in this sheath, and that the quantity of heat which one can produce by this process in a given time, and consequently the temperatures which can be obtained, are greater than those which can be produced by any other known means; in other words, one can by this process produce exceedingly intense heat very rapidly. An iron bar, for instance, 10 centimetres long and 1 centimetre in diameter, marked off every centimetre in length, can have every alternate section brought to the temperature of fusion while the remaining portions remain sufficiently cold that they can be touched by the hand, so rapidly is this heating effected. This process may be applied to tempering steel or to what is known as case-hardening. A bar of steel thus tempered on its external surface, when broken shows completely different structures in the middle and on the outside, the outside layer being perfectly definitely defined; the process affords a means for tempering on the outside only, the inside remaining soft. They also suggest that one could by this process study the magnetic properties of iron and steel.

Physiological Effects of High Frequency Currents.—"L'Ind. Elec.," March 25, gives an abstract of the paper by Dr. d'Arsonval (translated in the Lond. "Elec. Rev.," April 7), read before the French Physiological Society. The currents employed are of comparatively low tension, but of great current strength (.5 to 2 amperes), sufficient to bring an incandescent lamp of 110 volts and an 8 ampere to a white heat. Two small Leyden jars are mounted in series, their inner plates are connected to the secondary wires of an induction coil and sparks pass between the bulbs; the external plates are connected by a thick bare copper wire solenoid of 15 to 20 turns; the currents used in his experiments were branched off from the two ends of this solenoid; the sparks between these are much longer than those between the knobs of the Leyden jars. In passing these currents through the tissues he finds that there is no effect on the nerves of feeling or of motive power; the currents are not even felt although sufficient to illuminate a lamp consuming 2 amperes, held between two persons completing the circuit; there was a diminution of the excitability by ordinary currents in all the parts traversed by the high frequency current; sensitiveness to pain alone is suppressed at the electrodes for a period of one to twenty minutes; the nerves dilate to such an extent that the arterial pressure may be diminished more than a quarter of its value; these currents, therefore, penetrate, and he claims that their harmlessness does not arise from their flowing over the surface, but from the fact that their periods do not coincide with the period of sensitive nerves. He also placed the body in the selenoid itself insulated from it; it thus acts as a short circuited conductor for the induced currents; this was found to affect respiration and fermentation. He claims that all the nerve centres and probably all the tissues respond only to excitations of a certain frequency.

Alternating Currents and Rotary Fields.—Mr. Russell, in a short, well written article on this subject in the

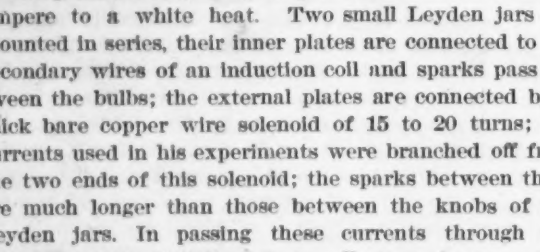


FIG. 1—ALTERNATING CURRENTS AND ROTARY FIELDS.

Lond. "Electrician," April 7, gives a very good summary accompanied by short explanations of various points not always clearly understood. He illustrates the varying values of an alternating current by means of a diagram, discusses their measurements, the effect of self-induction and capacity, and explains how two currents may be combined, and how to measure the power. In conclusion he describes the following simple method of producing a rotary field for experimental purposes. In the adjoining figures a ring made of thin strips of sheet iron is wound with four coils, which are connected as shown in the diagram, the points A B being connected to a source of simple alternating currents; the part between C and D includes a choking coil, and that between B and D an incandescent lamp, the two currents in these being equal; a revolving field will be produced in the interior of the ring as shown in the diagrams a, b and c. The arrow in each shows the direction of the lines of force at successive times differing by an eighth of a period. A com-

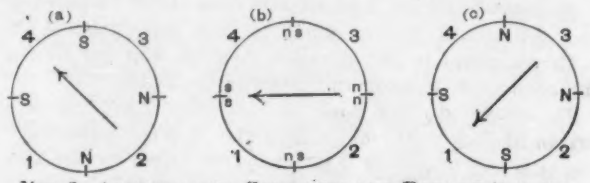


FIG. 2—ALTERNATING CURRENTS AND ROTARY FIELDS.

pass needle or a disc of iron pivoted at the centre and placed inside the ring will revolve with great rapidity; by interchanging the connections B and C the direction of rotation is reversed. The current flowing through the choking coil lags in phase nearly 90 degrees behind the phase of the E. M. F., while in the current through the lamp there is practically no lag; when the currents in 1 and 3 are a maximum, those in 2 and 4 are nearly zero. By winding a coil left-handedly instead of right-handedly the phase of the magnetizing force is reversed; for this reason four phases are obtained in the figure, from a two phase current.

Vacuum Tubes.—Referring to Mr. Rimington's article, abstracted in these columns in the issue of April 15, under the head of "Novel Electroscope," Mr. Kerdel writes to the Lond. "Electrician" that he found the same glow of light was produced in a tube by rubbing it on silk, flannel, etc.; if the tube was rubbed sideways along a long rubber the light continued in intermittent flashes for about five minutes after removing the rubber, the flashes being about five seconds apart. If the tube is discharged by drawing a conductor along it, a succession of cracks is heard, accompanied by flashes of light. An ordinary Geissler tube will produce the first effect, but continued flashes are seen only in tubes of high vacua.

Luminous Air.—In the issue of April 8 there appeared a short paragraph under this heading. Since then a translation of the original paper, together with an illustration, has appeared in the Lond. "Electrician," April 7, page 660. The subject of the paper is "On the Cathode Rays in Gases at the Pressure of the Atmosphere and in the Highest Vacuum." The paper is of considerable interest, but belongs more properly to the province of physics. As a result of his experiments the author claims that it is now possible to answer the question concerning the nature of cathode rays, and whether their propagation is conditioned by the presence of matter or whether they also pass through empty space.

Dielectric Hysteresis and Viscosity—Mr. Janet, before the French Academy of Sciences, showed that for rapid oscillation and equal difference of potential, the charges of a condenser are less for increasing than for decreasing potential, which difference he attributes to hysteresis or viscosity or both; it would require an infinitely long cycle to separate the hysteresis effect from those of viscosity.

MAGNETISM.

Magnetization of Iron.—Mr. Roessler concludes his long serial on the researches of the magnetization of iron due to very large and very small magnetizing forces in the "Elek. Zeitschrift," March 17 and 24. The last issue contains the tabulated results regarding the saturation point. He states that his results show very good agreement among themselves. In conclusion, he states that for wrought iron there is a limited value for the magnetization which is practically reached by a magnetizing force from 800 to 900 units, and lies in the neighborhood of 1,700, being a little above or a little below, depending on the composition of the particular piece of iron.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Arc Light Photometric Standard.—The article on the secondary standard proposed by Mr. Blondel, an abstract of which was published last week, is reprinted in full with illustrations in the Lond. "Electrician," April 7. Commenting on it editorially the "Electrician" says that before adopting it, it is necessary to know something of the degree of accuracy with which the observations have been made.

Variable Resistance.—The Lond. "Elec. Rev." describes and illustrates a convenient resistance which may be made to vary from ten to one million ohms, consisting essentially of a wet sponge placed between two contact plates, between which it may be compressed to a greater or less degree by means of a screw. It is intended to be used in connection with the medical application of currents.

DYNAMOS, MOTORS AND TRANSFORMERS.

Synchronous Alternate Current Motors.—In an article in the "Elek. Zeitschrift," April 7, Dr. Behn-Eschenburg discusses the subject of synchronous motors from a mathematical standpoint, giving the equations representing the conditions. From these he concludes that it is best to build the synchronous motors of the same type as the generators from which they are run; the calculation of the motors is similar in every respect to that of the generators, as they are similar machines whose efficiency is determined by the same conditions; in such a system the current will be half that which the machine would have if short-circuited, and the difference of potential at the generators (which must be distinguished from its E. M. F.) is half of its E. M. F.

"Hunting" of Parallel Alternators.—Mr. Swinburne, in an article in "Industries," reprinted in the Lond. "Elec. Rev.," calls attention to the fact noticed by Mr. Harrison that a certain alternator running as a motor increased and diminished its speed periodically, or "hunted," as it is called; also, that the exciting current varied at the same time, behaving like a direct current with an alternating current of long period superadded. Mr. Swinburne considers this statement to be of great importance. He states that it bears out his armature reaction theory in a remarkable way, and explains it in detail. Regarding the action of the field current, he states that the armature, owing to this oscillation, in which it acts alternately as a motor and as a generator, is strengthening and weakening the field once per oscillation; the fields do not respond instantly and lag a little behind owing to their self-induction.

The Hysteresis Theory of Brown's Motor.—Mr. Rimington, in the Lond. "Electrician," refers to a statement of Mr. Kingdon that "the theory of alternating currents gives the current in the secondary in quadrature with the primary current, was erroneous," and gives a short mathematical proof of it. He also asks that if the repulsion produced is due to hysteresis and not to self-induction, how Mr. Kingdon explains the repulsion of copper bodies when brought in an alternating field, as shown by Elihu Thomson, since in this case the moving parts have no iron.

ARC AND INCANDESCENT LIGHTS.

Small Arc Lamps and Incandescent Gas Lamps.—Dr. Heim, in a long article in the "Elek. Zeitschrift," April 7, gives the results of a large number of measurements of these two forms of lamps. He first measured an arc lamp of 1.5 amperes and 33 volts, with a positive carbon of 8 millimetres diameter and a negative carbon of 5 millimetres diameter; by laying off the well known "loop," giving the intensity at different angles, he finds that it is very narrow, much more so than is usual with arc lamps; the maximum c. p. was 118, and was between 30 and 40 degrees below the horizontal; the arc was only 0.5 millimetre in length, to which is attributed the small width of the loop; the mean intensity between the horizontal was 57.5 c. p., and the efficiency therefore .86 watt per candle, or about four times as good as that of incandescent electric lamps. He then tried a longer arc of 0.7 millimetre, for which 37 volts were required, and obtained 61.3 candles, or .905 watt per candle, showing a low efficiency and only a small increase in the width of the loop. By using smaller carbons of 5.5 and 3.1 millimetres, he finds that the width of the loop is materially increased, but the mean was only 47.5 c. p., and the efficiency 1.04 watts per candle, or 20 per cent. less than in the first case; it was therefore no improvement. The current was then increased to 2 amperes, which increased the width of the loop, showing that the crater was thereby increased in diameter; the mean intensity was 78 c. p., the efficiency .87 watt per candle, or no better than in the first case. He therefore concludes that the best conditions are 1.5 amperes at 33 volts, or 2.0 amperes at 34 volts, and in both cases using the larger carbons; an increase in the voltage gives less economy and the lamp burns less steadily. These lamps are usually run on multiple arc circuits, two in series for 106 volt circuits, and they must therefore have a dead resistance in circuit, which, if taken into account, makes the efficiency 1.38 and 1.36 watts per candle, respectively. The voltage never varied more than 0.5 volt, or 1.5 per cent. He then measured two incandescent gas lamps of about 48 and 29 c. p., for which he finds a consumption of a mean of 3.73 litres of gas per hour per candle for the mean intensity below the horizontal. (The loop-shaped curve in this case, however, has a nearly horizontal axis, and therefore probably more than half the light does not seem to have been included in this calculation; in the arc light the loop is almost entirely below the horizontal line.) At the rate of about 19 cents per kilowatt hour, and at about $1.10 per thousand cubic feet of gas, and assuming that the incandescent gas lamps have a mean intensity throughout their life of two-thirds of the initial intensity, he finds that the cost of the two lights is almost exactly alike. The article gives considerable detailed information, including diagrams of the loops and tables of the data.

Arc Versus Incandescent Lights for Street Lighting.—Mr. Walker, in the Lond. "Elec. Rev.," continues his discussion of the advisability of replacing arc lamps for street lighting by large incandescent lamps of 300 to 400 c. p. Besides enumerating the well known advantages, he states that they are more economical both in first cost and cost of working; against the cost of carbons, attendants and repairs of arc lamps, there is only the renewal of incandescent lamps; actual figures in the whole expense show that the working cost of large incandescent lamps, consuming the same energy as an arc lamp, is only 50 per cent of the latter. With improvements that he claims are sure to follow in a few years,

incandescent lamps will be made requiring only one watt per candle, and they will then give as much light per watt as an arc lamp.

Electric Light Versus Gas.—Mr. De Segundo concludes his long serial in the Lond. "Elec. Rev." In his former articles he showed that in most cases electric light costs considerably more than gas; in the present issue he makes some interesting deductions, showing that this difference in cost is almost counterbalanced by the cost of repainting repapering and in general renewing the decorations of a room which has been deteriorated by using gas; to prove this, he estimates the cost of these repairs, and the difference between the cost of the two illuminants; the small balance still in favor of the gas, he says, is probably counterbalanced by the decrease in damage to furniture, books, picture frames, and the enhanced purity of the air. He applies similar calculations to the case of a clubhouse, in which the conditions are somewhat different, but the results about the same. He states that it is usually admitted that public buildings lighted electrically require renovation only half as often as those lighted by gas. His conclusions are that the electric light would pay for its extra cost over gas in a club of any size, even if the supply were obtained from a central station.

TRANSMISSION OF POWER.

Belts.—The paper of Mr. Mavor, referred to in the last issue, is continued in the Lond. "Elec. Eng." He gives a very complete table of breaking strains of various belts used in England. He discusses the subject of leather belts at some length; he believes that any other kind of belt is uniformly unsatisfactory, owing to the liability to stretch and to wear irregularly; the breaking strain of the belt, he says, is an unimportant element, and may be left out of the consideration, as no leather belt is not strong enough to stand the normal strain, which is limited by other conditions; he also dismisses the subject of the strain due to centrifugal force; he approves of no joints but cemented ones, except for temporary fastenings, where, he says, only the laced butt joint should be used.

RAILWAYS.

Accumulator Traction.—Mr. Reymond-Schiller, in an article in the "Elek. Zeitschrift," April 7, on the calculation of accumulators for street railway, develops a simple formula for calculating the starting power per ton weight of car; he advocates using a battery having a capacity sufficient for two trips, but charging it every single trip; instead of moving the batteries into and out of the car, he recommends having as many cars as there are batteries, as the handling of the cells is injurious for the battery; the extra expense of the cars, he claims, is not greater than in the installation for handling the cells in the other case; the battery should be in a separate car, which is coupled to the motor car, the passengers being in the battery car. (But he then loses the advantages of the weight of the battery and the passengers for increasing the adherence at starting.) To prevent the battery from being discharged too rapidly, he recommends putting a resistance in circuit in preference to a fusible cut-out; he thinks it better still to use a battery of high internal resistance, in order to avoid a too great discharge current. In this case higher voltage than 100 would be used, which, he says, is no disadvantage, as one can then use a mixed system, namely, running the cars with accumulators through the heart of a city and with overhead trolley lines in the outskirts, the accumulator car being uncoupled at the beginning of the overhead line, where the battery is then charged. Such a mixed system, he thinks, is more likely to solve the problem of traction in cities, and he therefore recommends accumulator manufacturers to make trials with high tension batteries.

Magnetic Clutch Gearing for Railway Motors.—Several of the English papers contain illustrated descriptions of a variable speed gearing by Mr. Beaumont. In one form there are two spur wheels on the axle, one large and one small, each gearing with a pinion running loosely on the motor shaft; on this shaft and between these pinions is keyed a double circular magnet; by passing the current through either one or the other parts of this magnet, either of the two pinions may be clutched by means of magnetic friction; the motor may thereby be coupled to either one of the two pinions, or be released from both, thus enabling it to drive at two different speeds or to run loose. In another form, the motor runs loosely on the driving axle of the car; it is geared with the axle through four gear wheels, two of which are on a counter shaft, like the back gear of a lathe, which is carried by the framework of the motor. By means of magnetic clutches, the motor may transmit its power either through this train of gears or directly to the axle, by magnetically clutching the whole train of gears.

Berlin Elevated Railway.—The proposition for constructing an elevated electric railway in Berlin has been blocked for another year, on the ground that it would interfere with services in a church situated on the route (!). It will be remembered that for a similar reason an electric railway in London was delayed, but that, notwithstanding, its introduction was finally allowed; it is to be hoped that it will be the same in Berlin.

INSTALLATIONS, CENTRAL STATIONS AND ACCESSORIES.

Evaporative Condensers for Steam Engines.—In commenting on an apparatus described in Lond. "Industries" the "Electrician" states that the coal consumption, in one sense, forms a comparatively unimportant item in the expense of an electrical supply company, as it is only about 1-5 of the whole expense, instead of about 3-5 as in the case of isolated plants; if condensed water is pumped from a well on the premises, nearly as much coal will be spent in pumping as will be saved by the vacuum, and according to some engineers the work absorbed by the air pump is a serious proportion of the work gained. It comments on the air or evaporative condenser described in that article, consisting of a stack of pipes through which the exhaust steam passes, and over the outside of which cooling water is allowed to trickle, which by its evaporation acts as a condenser. In marine condensers 1 square foot is allowed per indicated h. p.; for land engines in the tropics about 2½ square feet, and for evaporative condensers up to 10 square feet. For surface condensers the weight of the cooling water is about 20 times the weight of the feed, while in the evaporative condensers it becomes equal to or even less than the feed; its advocates state that shortness of water is no excuse for not condensing, as such condensers will actually save water. It is not necessary to provide a condenser plant capable of dealing with the exhaust at full loads, as such condensers might be employed with great advantage on light loads. Their construction is extremely simple, is not burdened with patents and requires no change in the existing plant except possibly where there is lavish lubrication of the cylinders.

Electricity on War Ships.—In a recent paper by Mr. Soliani, of the Italian Admiralty, he discusses the advantages and the disadvantages of electric power on board ships. After mentioning the advantages (which are already well known), he states that among the disadvantages is the high speed of the motors, which limits their application and involves troublesome gearing; also the difficulty of locating faults in electric circuits; their liability to suffer from water; electric motors are not well adapted for operating the rudder, the anchor, etc., in which the resistance to be overcome may change suddenly. On the whole, he thinks that the application of electric motors on board ships is not as extensive as might at first appear, and that great improvements must be made before they can supersede present means for transmission. Sixty-five volts, which at present is used for lighting, he states, is not adequate for a general system of transmitting and distributing power on account of the very great currents required.

Central Stations in Switzerland.—"L'Ind. Elec.," March 10, gives a list of all the central stations in Switzerland at the beginning of this year, including some tabulated information about each one. As a rule, they are quite small, and the majority use continuous currents.

Clermont-Ferrand Central Station.—"L'Ind. Elec.," March 10, gives a description of this station, in which high tension alternating currents are used. The station is run in connection with a gas generating apparatus, the hot gases from which are utilized to heat the water for the electric station. The description includes four large cuts, two of which show the switchboard in detail. This same number contains a description of a large private plant in Paris.

Hanover Station.—A description of this station, mentioned in these columns March 25, is concluded in the "Elek. Zeitschrift," March 31. The present installment includes very full data concerning the operation of the boilers, engines, dynamos and accumulators, and is accompanied by a number of load diagrams; the latter may be understood by one having but a slight knowledge of German; the data covers a period of one year. An interesting factor, which will surprise many Americans, is that the average efficiency of the accumulators for one year was 91.9 per cent. in ampere hours and 78.4 per cent. in watt hours.

Dusseldorf Accumulator Station.—In the "Elek. Zeitschrift," April 7, Mr. Uppenborn describes at considerable length the municipal station in the city of Dusseldorf, Germany, for 20,000 lamps, in which accumulators, charged by low tension currents, are used. The description is very complete and is accompanied by 21 illustrations, including diagrams, views, connections, etc., many of which are quite large and clear, showing considerable detail; the diagrams themselves are sufficiently clear to be understood even by those who cannot follow the German text. As this is probably one of the finest installations in Germany it is well worth the attention of those interested in central stations.

New Paris Station.—The Lond. "Elec. Rev." gives a short description of the new sector in Paris covering the Champs Elysees quarter.

Accumulator Switch.—The Lond. "Electrician" describes and illustrates the "Neville" switch intended to prevent the battery current from discharging itself through the dynamo. It is constructed on the principle of a polarized relay; as soon as the E. M. F. of the dynamo exceeds that of a battery by one or two per cent. the circuit is automatically closed by a copper fork in mercury cups; the opening and closing being effected when the two E. M. Fs. are practically the same. The current passing at the start is quite small; it therefore overcomes the objections to other switches, which cause sudden and great rushes of current.

Safety Device for Accumulators.—In order to protect accumulators from being charged or discharged too rapidly a fusible plug is often used which, however, in many cases is not permissible; particularly in central stations where it will not do to cut off the current. To overcome this objection an apparatus, described by Mr. Trumpy in the "Elek. Zeitschrift," March 31, is used in Germany. Should the current exceed the maximum allowable value the apparatus rings a bell in order to signal the attendant; should this current continue for more than five minutes it is registered for every period of five minutes; in cases where the attendant may not be within call the apparatus, instead of opening the circuit, connects a suitable resistance into the circuit which diminishes the current by a proper amount.

Specifications.—Mr. Tomlinson concludes his serial in the Lond. "Elec. Rev. on "The Specifications of Electric Plants and Mains for Open Competition;" in the present issue he summarizes what should and what should not be included in the specification, and gives views which, though they may not all apply in this country, are nevertheless worth the attention of those engaged in drawing up specifications.

WIRES AND WIRING.

Concentric Wiring.—Mr. Walker, in the Lond. "Electrician," comments on the article of Mr. Mavor on this subject (abstracted in these columns in the issue of March 18). He states that it infringes a rule which he believes necessary for the duration of cables, namely, that there shall be no metallic conductor outside of the insulating envelope, as the act of putting on this envelope strains and often damages insulation; these faults are often not detected, but lead to breakdowns later on; he objects strongly to the grounding of the outer conductor, claiming that it is a mistake to believe that in so doing one of the conductors is of zero potential. He denies that a concentric cable cannot create a fire, citing a case in which it did so owing to the fusion of the outer conductor (in such a system the outer conductor, being grounded wherever possible, cannot well be protected by fuses). In damp places he prefers doubling the length of cable if by so doing a joint in the damp place can be avoided; if such joints are necessary, however, they should always be in sight.

Parallel Distribution.—In the first part of an article on this subject by Mr. Jehl, in the Lond. "Electrician," April 7, he compares the four systems of distribution: first, the simple direct method; second, the feeder method; third, the single loop method; and, fourth, the double loop method. (The article is interesting as a study and gives some useful comparative data, which, however, must be accepted with caution as the relative values of these systems depend very largely on the conditions of the special case to which they are applied.) He first compares them, assuming a constant current density, and shows the relative weights of copper required. The single and double loop systems appear to require about double that in the direct system, while the feeder system is about midway between the two. He next considers the subject of regulation, that is, the loss of voltage; in the particular case assumed, in which the weight of metal is the same in both, he finds that in the feeder system the regulation is 2.6 times better than in the direct system. The article is brief and to the point and involves only very little mathematics.

Insulation Resistance of House Circuits.—Mr. Carter, in the Lond. "Electrician," calls attention to the great diversity of opinion on the subject of a standard insulation resistance for a private house lamp circuit. In comparing all the rules in use he finds they follow more or less closely the following law: $r = k \div n^2$ or $R = k \div n$, in which r is the insulation resistance per lamp, R that for all the lamps, n the number of lamps and k a constant, which is the number of megohms of the circuit with only one lamp in circuit. He finds that this numerical constant is from 75 to 2 megohms in the rules of the London Electric Supply Corporation, 12.5 for the Phoenix Fire Office rules, 10 for the Bradford Corporation and Prof. Jamieson's rules, 0.87 for the Institution of Electrical Engineers' rules and 75 for Kempe's rules; curves are given showing the total insulation for varying numbers of lamps according to these different rules. He points out that a very wide range in insulation resistance involves only a trifling variation in the cost of materials.

Underground Mains in Paris.—"L'Electricien" contains a very well illustrated article on the mains in one of the large central stations in Paris, which is translated in full in the Lond. "Elec. Eng.," April 7. The mains used are for alternating currents of 3,000 volts with transformers at each house or group of houses; they are concentric flexible cables laid in trenches on a layer of sand and covered with terra-cotta tiles, which are themselves covered some distance above them by an iron wire netting. The illustrations show the joints, junction boxes and a cross-section of the cable. The article includes a description of the manufacture of the cable.

Joint Boxes.—The Lond. "Elec. Rev" describes and illustrates the Bowden joint boxes for high tension

alternating currents, which it appears to recommend very highly.

TELEPHONY.

Telephone Lines.—In the city of Pressburg a new method of running the wires is being introduced; instead of carrying the lines along the front or on the roofs of houses they are run zigzag across the street independent of the length of the span or of the regulating of the same; by this means fewer supports and insulators are required; where 30 to 40 were formerly used they now require only from 8 to 10; the increased wire is said to be insignificant compared with the saving in the insulators.

Speed of Telephoning.—In the London-Paris telephon line trained stenographers have been used, and by this means 400 words may be transmitted in the limited period of three minutes. More recently these stenographers have become very expert, and are now said to transmit 576 words in three minutes.

Pocket Telephones for Policemen.—In Newcastle, England, policemen, constables and other such officials, carry small pocket telephones which they can connect to any fire alarm box, and by which they can not only give a signal, but can follow the same with more detailed information which is often preferable to a mere signal; such an arrangement seems to be far simpler than the cumbersome telephone boxes used in some of our cities.

ELECTRO-CHEMISTRY.

Purification of Lead by Electrolysis.—According to the Lond. "Elec. Rev." the following process has been introduced. The chlorides of calcium and magnesium are decomposed with lead nitrate, and the lead chloride so formed is utilized for the electrolytic production of chlorine; the nitrates of calcium and magnesium which are produced are heated to recover the nitric acid which is used for dissolving further quantities of crude oxide lead. Silver and other metals may be precipitated from this solution by the addition of spongy lead. In an alternative method hydrochloric acid is used instead of the chlorides. The fused chloride is electrolyzed in a glazed earthenware or enamelled iron vessel, kept at a suitable temperature, closed at the top and provided with a feed pipe for the lead chloride, a chlorine out-let pipe, and a syphon for drawing off the purified melted lead. Both electrodes may be made of solid carbon or of an iron core covered with carbon, or one may be carbon and the other (cathode) the molten lead.

Steel Coated with Lead Peroxide.—A German journal states that steel can be electrolytically coated with peroxide of lead in 20 minutes; no other data, however, is given; such a coating being an oxide is proof against atmospheric influences and protects the steel from rusting; as the operation is conducted at the ordinary temperature the temper of the steel is not affected. (Electrolytically deposited lead peroxide is harder than the hardest steel, and it will therefore probably wear very well; it has a fine rich lustre, but is brittle; it can readily be deposited on non-oxidizable metals such as carbon, platinum and even nickle; it would therefore be of special interest to know how it could be deposited on iron; also whether the process is continuous, as the solution loses lead at both poles.)

Electrolytic Installation.—A comparative inexpensive and simple plant for the industrial decomposition of alkaline chlorides, devised by Mr. Faure, is described in the Lond. "Elec. Rev." as consisting of a number of electrolytic vessels formed by porous brick walls; diaphragms of porous material are arranged parallel to these walls. Partitions made of a mixture of clay, carbon and bitumen baked in a kiln are used as electrodes. Each compartment which is formed between two electrodes is rendered fluid tight by being cemented with bituminous cement. The spaces between the electrodes and the diaphragms and walls are filled with dense coke which serves as an electrode and protects the electrode proper from the action of electrolysis.

Electric Tanning.—A paper read by Mr. Falkenstein before the Institution of Electrical Engineers is given in full in the Lond. "Elec. Eng.," April 7. Besides giving a short description of the process of tanning in general he describes briefly the various processes and the results of a number of experimental tests made by himself. The article is of considerable interest to those engaged in such processes and forms probably one of the best short summaries of this much discussed subject.

Dry Cells.—The comparative tests of the Hellesen and the E. C. C. dry cells, mentioned last week, are described at considerable length in the Lond. "Elec. Rev.," March 31, and April 7. The tests include numerous curves and data, besides descriptions of all the methods of testing. The results are of especial interest to the manufacturers of dry cells, while the methods used are of especial interest to students and others making similar tests. The paper forms probably the most complete test of dry cells published. In general the E. C. C. cell seems to be superior. In a bell ringing test the cells were made to ring a bell for six minutes with periods of rest of six minutes; the Hellesen failed after 231 hours (including the periods of rest), while the E. C. C. failed after 498 hours.

A Monster Accumulator.—A European firm has constructed a single Tudor accumulator having a capacity of 27,200 ampere hours, a discharge current of 7,680 ampere hours; its length, breadth and heighth are 7.7, 5, and 4 feet, respectively. Its weight is about 20,000 pounds and the price about $2,000.

MISCELLANEOUS.

Ozone.—The serial in the Lond. "Elec. Rev." is concluded in the issue of March 31. It is entitled "Applications of Ozone," but might better have been termed a collective description of the various forms of ozone generating apparatus from the earliest form to those of the present time; the latter subject it appears to cover very completely, and any one interested in the subject will probably find nowhere a better compilation; the serial has been illustrated with 29 cuts of such apparatus. Besides describing the later forms of apparatus in the present issue, the author states that he cannot indorse the theory of Fahrig that "it is a mistaken idea that ozone can be produced at any per cent. of strength, that 6 to 7 per cent. is about the strongest one would care to handle and that one per cent. of ozone is strong enough for any commercial oxidation." In an apparatus used in the United States, it is claimed that 240 grammes are produced per horse power hour, with alternators having a frequency of 50. The author does not care to accept this without fuller details. A plant in Amsterdam consists of a 25-kilowatt alternator, several 8-kilowatt transformers raising the potential from 100 to 25,000 volts and 3 ozonizing chambers each about $10 \times 6 \times 4$ feet; each chamber contains 16 ozonizers, which absorb 8 kilowatts each.

The older forms of ozonizers, as a rule, consist of closed tubes or plates having a flat electrode on one side; ozone, however, is generated in larger quantities from electrodes having points than from flat surfaces, on which the tension is weak and uniform; the best form of the electricity is, furthermore, what is known as the silent discharge, the disruptive discharge being much less favorable, and when there is no glow there is no ozone; from experiments it appears, furthermore, that the generation depends specially on the rise of the temperature of the oxygen under the influence of the electric discharge. The construction of the Andreoli ozonizers is based on the use of points instead of plates; such an apparatus will, therefore, operate in the air of any apartment through which the ozone will be diffused without any tubes or mechanical means for producing a draught. Six forms of this ozonizer, for different purposes, are illustrated in the article, some being in the form of a somewhat ornamental standing or hanging device to be introduced into rooms. In this open apparatus there is no rise of temperature, which, he says, is well known to retard the production of ozone (although in the same article he states that the generation depends on the rise of temperature).

Electric Furnace.—Two forms of the Moissan electric furnace are illustrated in "L' Ind. Elec.," March 25, one of which was described in these columns. The carbon crucible and other carbon portions of this furnace should be made as pure as possible, of powdered retort carbon and coal tar, being careful to have no boric acid in the mixture.

Uranium.—Mr. Moissan, before the French Academy of Sciences, stated that the electric furnace allows of the rapid preparation of refractory metals which were formerly difficult to obtain. The mixture of oxide and carbon is placed in a crucible of retort carbon which is placed in the cavity of a lime furnace containing magnesia, which latter is absolutely stable at the temperature of the arc. If the metal is volatile a current of hydrogen gas is passed through the furnace, the metallic vapors being collected and condensed in a cool receiver; calcium, barium and strontium are thus prepared. Non-volatile metals like uranium remain at the bottom of the crucible in the form of an ingot. This metal is obtained by a calcining in a porcelain cup, nitrate of uranium, which can be prepared in great purity; the mixture thus obtained is strongly compressed in a carbon crucible mixed with powdered carbon and placed in an electric furnace in a current of 450 amperes and 60 volts, in which the reduction is completed in a few moments. When pieces of this metal are shaken up in a glass bottle they give brilliant sparks due to the combustion of small portions. A few other details will be found in the Lond. "Elec. Eng.," March 31.

Electric Welding.—According to the Lond. "Elec. Eng.," Mr. Slaviankoff has devised a method for electric welding adapted to repairing broken pieces of machinery. The description is too meagre to be of any use. It appears to consist of melting the metal to be cast around the broken pieces, by the electric arc in a special tool, while at the same time the other pole is attached to the metal to be repaired.

Electric Tempering.—A method of tempering electrically will be found described under the heading "Rapid and Intense Heating Effect."

Gutta Percha.—Mr. Lagard states that ordinary gutta percha contains, besides the pure material, two resins known as fluavile and albane; they are oxides of the pure material, the former containing one, and the latter two atoms of oxygen, while the pure material contains no oxygen; he shows that the greater the proportion of these resins, especially the latter, the better the insulation quality. An examination of gutta percha for its insulating properties ought, therefore, to include a determination of the amounts of these materials. Poor qualities always contain large quantities of albane; if the temperature, during the preparation of the material, becomes too high, it is favorable for the oxidation of the pure material.

Earth Currents.—In a paper reprinted in the Lond. "Elec. Rev." April 7, Mr. Walker gives some interesting observations regarding earth currents in India. In discussing Mr. Walker's paper, Mr. Preece said that what electricians should measure is the E. M. F. between two points, and not the current that happens to flow in a particular wire connecting the points. "Industries" adds that the E. M. F. of polarization of the earth plates should be eliminated, and for this, two or three readings would be advisable; one on open circuit after a long rest, one after the earth current has been flowing for some time, and one with a reversed current from a known E. M. F.

Lightning Rods.—A German firm has introduced points for lightning rods made of retort carbon ground to a fine point and having a very secure connection to brass holders fastened to the ends of the rods. (The idea seems to be very good; the advantages, besides cheapness, are that it will not oxidize, and that it will not be melted by the lightning.)

A Photographers' Pencil.—In retouching the defective lines or spots on a negative plate, very short and numerous strokes of the pencil have to be made with great care; it is, therefore, a slow process. An instrument to overcome this is illustrated in the Lond. "Elec. Rev." consisting essentially of a pencil pivoted in a holder not far from its end, the upper end being caused to vibrate by means of a coil and contact breaker; the point makes about 2,000 very short strokes per minute; it is said to be more reliable than the rotating form which has been used in this country.

The Training of Electrical Engineers.—The Lond. "Elec. Eng.," April 7, contains an anonymous article on this subject, which is interesting reading for both students and their teachers, as also for their future employers.

Toothache.—A European dentist is stated to have had great success in curing toothache within five to six minutes, and often in less time, by applying one pole of an electrostatic machine to the troublesome tooth, and the other pole to the body of the patients; in 76 cases only three were unsatisfactory.

NEW BOOKS.

LOGARITHMIC TABLES. By Prof. George William Jones, Cornell University. Fourth edition. London: Macmillan & Co. Ithaca, N. Y.: George W. Jones. 1893. 160 pages. Price $1.00.

The logarithmic tables in common use among students and engineers are gathered in this volume and printed on paper likely to withstand for a considerable period the constant thumbing such a volume has to undergo. The arrangement of the tables is convenient, and the typography is clear and well executed. Besides the usual tables of common and natural and trigonometric function logarithms, there are tables of Constants of Mathematics and Nature, Addition and Subtraction Logarithms, Square and Cubic Powers and Roots, Reciprocals, Quarter Squares, Bessel's and Binomial Coefficients, Errors of Observation and Prime and Composite Numbers. The common logarithms are represented by four-figure four-place and four-figure six-place tables, and the trigonometric functions by a six-place table of logarithms and five-place table of natural functions, a table for small angles and another of four-place logarithms. The first and last mentioned will be convenient for much practical work.

TELEPHONE LINES AND THEIR PROPERTIES. By William J. Hopkins, Professor in Physics in the Drexel Institute of Art, Science and Industry. New York: Longmans, Green & Co. 1893 258 pages, illustrated. Price, $1.50.

This useful work, as somewhat indicated by the title, deals with the design, construction and material of telephone lines, aerial and underground, and with their electrical properties. There is also a chapter on exchanges, another on switchboards and several on the principles of telephone currents in which the latest views in regard to wave propagation are given.

The subjects are treated in such a way as to prove interesting and instructive to the general reader as well as to the technical student, and the few mathematical demonstrations are put in footnotes. While the theoretical principles governing the various matters treated are explained, particular attention is paid to their practical applications, the book combining in a happy manner correct theory with correct practice. The book is a useful addition to the literature on the subject, and can be safely recommended to those interested.

THE MEASUREMENT OF ELECTRIC CURRENTS. ELECTRIC MEASURING INSTRUMENTS. By James Swinburne, M. Inst. E. E. METERS FOR ELECTRICAL ENERGY. By C. H. Wordingham. Assoc. M. Inst. E. E. Edited by T. Commerford Martin. New York. D. Van Nostrand Company. 1893. 237 pages, illustrated. Price 50 cents.

The object of these papers, reprinted from the Transactions of the Institution of Civil Engineers, is to review the advances of late years in commercial instruments for measuring commercial currents. The subjects are treated in considerable detail from a practical standpoint, and the instructive discussion on Mr. Swinburne's

paper is added. To those who wish to be up to date on electrical measuring instruments this little book will be very useful.

THE TRANSMITTED WORD. By W. J. Keenan and James Riley. Boston: Dorchester Press Co. 1893. 113 pages, 7 illus. Price, cloth, 75 cents; paper, 50 cents.

"This little book," we are informed, "was written in this wise: Mr. Riley, the well known journalist and poet, but who is not an expert electrician, took the ideas as furnished by Mr. Keenan, for many years, and until very lately, superintendent of this (Dorchester) district for the telephone company, and clothed them in his language, making a narrative perforce therefore that any other non-expert reader can comprehend. It is written in Mr. Riley's well known easy, flowing style, with an occasional poetical burst or dainty pen picture." Fortunately the combined efforts are so joined that the reader can easily skip the poetical bursts of Mr. Riley and read the sensible technical prose of Mr. Keenan, and to those who care to do this the book will no doubt prove useful.

TIPS TO INVENTORS; TELLING WHAT INVENTIONS ARE NEEDED, AND HOW TO PERFECT AND DEVELOP NEW IDEAS IN ANY LINES. By Robert Grimshaw, Ph.D., M. E. New York: The Practical Publishing Company. 1893. 84 pages. Price $1.00.

The hints for inventors contained in this little book are of unusual value as being the product of a level-headed man with great practical experience in industrial matters who has definite ideas as to what new inventions are needed and will pay. Ten sections deal with as many branches of industries, including electrical, another with miscellaneous ones, and the two concluding sections with perfecting, developing and selling patents. Perhaps the author is rash in advising inventors to seek a method to store up lightning, and he is a little behind the times on electrical cooking apparatus, but with very few exceptions the suggestions are characterized by sound common sense.

ELECTRICAL TABLES AND MEMORANDA. By Silvanus P. Thompson. D. Sc., B. A., F. R. S., and Eustace Thomas. London: E. & F. N. Spon. 1893. 2¼ × 2 × ¼ inches. 128 pages, 16 illustrations Price 50 cents.

This miniature volume is designed for the vest pocket, and contains information for electrical engineers and electricians that is likely to be in frequent demand. Notwithstanding the small size of the volume it contains a great deal of useful information which seems to have been carefully selected with reference to its practical bearing.

CARTE DES LIGNES TELEGRAPHIQUES ET CABLES SOUS-MARINS. Ch. Delagrave, 15 Rue Soufflot, Paris. Price, 2 fr. 50.

This chart, measuring 39 × 27 inches, represents the various telegraph lines and sub-marine cables of the world, and gives the tariffs charged, including press rates, and other information.

Nikola Tesla and His Wonderful Discoveries.*

Nikola Tesla has been called by scientific men, who do not award praise freely or indiscriminately, "the greatest living electrician." At the recent convention of electricians held in St. Louis, a well known electric journal, issued daily bulletins or "extras" giving a list of the delegates and distinguished attendants as they arrived at the convention, a programme of the day's proceedings and a special article of immediate interest having reference to the current discussions of the convention.

One evening during the session of the convention Mr. Tesla lectured on some of his recent experiments. The bulletin for that day contained a brief account of his life. So great is the interest taken in this young man that over four thousand copies of the journal containing this biographical sketch were sold upon the streets of St. Louis—something unprecedented in the history of electrical journalism—and in the evening his lecture, in the Grand Music Entertainment Hall, was listened to by a larger audience than had ever been gathered together before in the United States on an occasion of this kind. Many were glad to purchase the complimentary tickets at $4 or $5 a piece.

It is singular that this remarkable man should have come to us from one of the smallest and least known nations of Europe, Montenegro; that he is a young man (only thirty-six years of age), and that the best scientific minds believe he has only begun to give the world the result of valuable researches.

In a recent symposium on the subject of electricity the contributors mentioned his name with a sort of reverence, as one who has an almost magic power over the most hidden secrets of nature. Men in the foremost ranks of science, not only in the United States but in Europe, believe that at no distant day he will announce discoveries which will be as far in advance of our present knowledge of electricity as the telegraph was over the mail coach. He has delivered only three or four lectures—one in Philadelphia, one in St. Louis, another in Paris and another in London—but each lecture has been listened to and applauded by the very creme de la creme of the scientific world.

MODESTY ONE OF HIS VIRTUES.

Another remarkable characteristic about Mr. Tesla—especially when we consider the self-assertive age in which we live—is his modesty. This serves to make him more highly esteemed by his associates and only adds to his renown. His friends might truly exclaim with the old dramatist, "Thy modesty is a flambeau to thy merit."

It is only affirming the truth when it is stated that many of the high compliments he receives annoy him. He honestly does not believe he is entitled to the praise that is continually showered upon him. He is an enthusiastic worker in his profession, but believes that he is only one of the standard bearers in the great march of human progress and that he is as much indebted to other minds who have studied and worked in this new science as others think they are indebted to him. In his famous London lecture, after expressing how deeply he felt the honor of addressing the foremost thinkers of the day, his next sentence showed the character of the man. He said:

"The results which I have the honor to present before such a gathering I cannot call my own. There are among you not a few who can lay better claim than myself to any feature of merit which this work may contain. I need not mention many names which are world known—names of those among you who are recognized as the leaders in this enchanting science, but one, at least, I must mention—a name which could not be omitted in a demonstration of this kind. It is a name associated with the most beautiful invention ever made. It is Crookes."

Crookes is a writer famous for his descriptions of experiments on radiant matter.

A REMARKABLE MOTHER.

Mr. Tesla, like many famous men, had a remarkable mother. She died only two years ago at the age of sixty. She was a simple woman, but in the surrounding territory in which she lived, both far and near, was considered the most remarkable female in the land. She inherited the inventive spirit from Mr. Tesla's grandfather, an inventor and constructor of machinery, who was an exceptionally ingenious man. Old Mrs. Tesla was an indefatigable worker. As a rule she arose at four o'clock in the morning and every day worked until late at night.

The home of the Teslas was in a very wild country, away from any of the conveniences of civilization, and Mrs. Tesla displayed her inventive faculty by constructing nearly all the appliances that were necessary for use in the household, and that, too, without ever having seen patterns from which to make them. For instance, in the matter of weaving, she would plant the hemp and flax, get out the fibre, spin thread and then construct the necessary mechanical appliances for weaving, making her own loom and producing for her large family all kinds of cloth from the heaviest, suitable for outdoor garments in the winter, down to the finest pieces, suitable for embroidery work. When she died, so great was she held in esteem that the whole country for miles around mourned her loss.

Mr. Tesla is such a hard worker that he has little time for social pleasures, if, indeed, he has any taste in that direction. He is a bachelor, tall, very spare of build, has dark, deep set eyes, jet black hair and an expression that suggests at once the deep thinker. Though polite and even friendly to newspaper men, he has no desire to exploit himself in print. He has been the talk of the scientific world for five years, but the fololwing interview I had with him a few days ago is the first that has ever appeared in any journal:

TESLA'S AUTOBIOGRAPHY.

My interview with Mr. Tesla commenced with a request that he give me a brief account of his life. He replied:

"I was born in a little place called Smiljan, on the border country of Austria-Hungary, this special section of territory being known as Lika. I am now thirty-six years of age. I have gone through the educational training that a young man usually receives in Europe, and nearly eighteen years of my life have been spent in schools. I completed my preparatory in Gospich and Carlstatt, and the Polytechnic School in Gratz, Austria. My first employment was in engineering; then I was connected with the Hungarian Government Telegraph Company; afterward I engaged in telephonic work. After this I was interested in the electric light industry, and finally in the transmission of power.

"In 1884 I came to this country, my principal object being to develop certain ideas of inventions which I had vainly tried to develop in Europe. For a while I worked with Edison. In the beginning of 1885 a company was formed in my name. I developed for this company certain inventions, brought out a system of lighting and peculiar appliances belonging to that system. In the following year another company was formed—some time in 1886—the object of which was to introduce a motor of my invention. This motor is based on what is now the well known discovery of the rotating magnetic field, as it is technically called. The best way to give an idea of this discovery to one who is not technically educated in these matters is to put it as follows:

"A magnet, as it is well known, will attract a piece of wire and hold it. It was my good fortune to discover a method of constructing a magnet in such a way that it would not hold the iron, but spin it round and round."

I asked Mr. Tesla to kindly give me some further information in regard to his family.

TESLA'S FAMILY AND HOME.

"My father," he continued, "was a prominent clergyman attached to the Greek Oriental Church, an orator and a writer of note. He was a man highly educated, who spoke fluently a great many languages and also ranked high as a mathematician. He was an omnivorous reader and possessed a large library from which it was my privilege to gather a great deal of information during the years of my life spent at home. My uncle, his brother, was another skilled mathematician, and professor of a military academy in Austria. He wrote a number of standard works on mathematics.

"My mother died about two years ago. One of her brothers—the youngest—is one of the leading dignitaries in the Greek Oriental Church, having the rank of a cardinal. He is comparatively a young man and a famous orator.

"The section of country in which I was born was an exceedingly wild region—a mountainous and rocky region—with, however, many stretches of beautiful scenery, but poor from the agricultural point of view. In fact, they had a homely though somewhat sacrilegious saying in our land, that when God distributed the rocks over the earth He carried them in a sack, and that when he was above our land the sack broke.

"I was interested in electricity almost from the beginning of my educational career. I read all that I could find on the subject. All the phenomena I witnessed in this line only excited my interest. When I was a mere boy I began to experiment with batteries and induction coils, also with frictional and static machines. When I attended the Polytechnic School at Gratz I began to devote more and more of my time to electrical studies, and after I left the school I may say that, practically, all my time was taken up with the study of electricity.

EVIDENCES OF GENIUS.

"Originally, I closely followed up the course of mathematics and physics with the view of graduating as a professor of those sciences. It was, I think, in 1875 or 1876 that we experimented in the Polythecnic School with one of the first practical dynamo machines, which was brought out by M. Gramme, a Frenchman. It occurred to me that a machine might be constructed without the complication of what is technically called commutator and brushes. A commutator is used on electric current generators and motors and on induction coils and elsewhere for changing the direction of currents. The brushes are pieces of copper or other material that bear against the cylindrical surface of the commutator.

"I remember that my professor at that time tried to demonstrate that such a machine was out of the question—in fact, an impossibility. I must confess to a feeling that I, in common with many better men, have had from early youth. As a youth, when I was told that a certain thing was impossible, it only served to arouse within me a spirit of contradiction. In this particular instance I began to think about and to work on a machine made according to the idea that had occurred to me. Day and night, year after year, I worked incessantly.

"After working several years I am happy to say that I was able to produce a motor which is now gradually being introduced in the United States. It is a machine of ideal simplicity, requiring no attention whatever. It should be remembered that in recent years there has been a wonderful advance along almost all electrical lines. What were at one time supposed to be novel or impossible schemes of doubtful accomplishment have proved to be feasible. Encouraged by this condition of affairs I afterward devoted my energies to the production of a more practical illuminant than we have at present and am still pursuing my labors in this direction.

DISCOVERIES ABOUT LIGHT.

"The most wonderful phenomenon in nature is light and the most remarkable feature connected with man's physical life is the eye, which is the only organ capable of being affected directly by the vibrations of the ether. We could see for an immense distance if it were not for gases and particles that fill up the intervening space. These absorb the energies of the air.

"In pursuing this line of work I have had the good fortune to discover some facts, which are certainly novel and which, I am glad to say, have been recognized by scientific men both here and abroad. I think the probable result of these investigations will be the production of a more efficient source of light, thus supplanting the wasteful processes of light production.

"My experiments have been almost entirely confined to alternating currents of high potential. An alternating current is a current changed periodically in direction, and the word potential expresses the force and energy with which these currents are made to pass. In this particular case the force is very great. The fact that a current vibrates back and forth rapidly in this way tends to set up or create waves in the ether, which is a hypothetical thing that was invented to explain the phenomena of light.

"These currents permeate all space—not only the atmosphere, but solids as well—and the waves extend out in concentric spheres indefinitely into space. I utilize

* From the New York *Herald*, April 23, 1893.

these waves in some of my experiments to produce certain phenomena. It is not an electric current in the sense in which we are popularly accustomed to use that term.

TRANSMITTING ENERGY THROUGH AIR.

"These experiments may be further illustrated in this way: Suppose you throw a stone in the centre of a pool of water. While there would be no transmission of water from the point where the stone landed to the shore, yet the waves would reach the shore and exert force on the shore. In a similar way I utilize the force which I obtain in the manner described.

"One result of my investigations, the possibility of which has been proved by experiment, is the transmission of energy through the air. I advanced that idea some time ago, and I am happy to say it is now receiving some attention from scientific men.

"The plan I have suggested is to disturb by powerful machinery the electricity of the earth, thus setting it in vibration. Proper appliances will be constructed to take up the energy transmitted by these vibrations, transforming them into a suitable form of power to be made available for the practical wants of life. Primarily the agent that I propose to use consists of an old-fashioned electrical spark, such as they light from a Leyden jar. This is rapidly discharged back and forth an enormous number of times. Every time that the spark seems to pass it is in reality passing hundreds of thousands of times, and each time it passes it sets up these waves in the ether which extend out into space. In other words, the result of the experiment is to disturb the equilibrium of the ether.

"I am hopeful that in no distant time this method will be deemed worthy of a practical trial. It may be proper to say that among other things I have already demonstrated that we do not need to have two wires to convey an electric current, one wire being sufficient, and, in fact, in some cases, better than two wires.

PHENOMENA OF RESONANCE.

"In the experiments of transmitting power by means of wires the phenomena of resonance is to be observed. If one tuning fork, for instance, is set into vibration another one of the same pitch, anywhere within reasonable distance, will respond. That is a familiar phenomena of sound termed resonance. Now, if I set up these etheric vibrations that I speak of to a certain pitch, and my wire is within reach of these vibrations (not necessarily metallically connected) it will respond provided its pitch corresponds with that of the etheric vibration.

"In that way I obtain energy in another conductor without any metallic connection whatever. Where a single conductor is connected with the source of vibratory energy these waves surge back and forth in that conductor very much as water would in a tube when you reverse it back and forth.

"One of my most interesting experiments is with the incandescent lamp with a single wire to it. I place in the centre of this a piece of very refractory substance of any kind and connect that with the source of vibratory energy, and, with this as a centre, these etheric waves are sent out in concentric spheres and are reflected back from the inner surface of the glass globe upon this small piece of refractory substance. The impact of the molecules of rarified air in this globe creates such intense heat in this refractory substance (which is the focus) as to bring it to a high state of incandescence. It is difficult to find a substance that will stand that heat, but I have found some substances that stand it fairly well.

"The transmission through the earth can be effected at any distance; in fact, it matters little whether the distance is small or great.

OF INCALCULABLE VALUE.

"Such a result, if achieved, would, of course, be of incalculable value to the world and greatly advance the progress of the human race. In this great country (of which I am proud to be a citizen) we have water powers which, in aggregate amount, are sufficient to supply all the needs—in fact, far more than the needs—of the whole human race. Take, for instance, Niagara. This famous waterfall is estimated variously all the way from five to six millions horse power. Now, four millions horse power, economically directed, would light every lamp, drive every railroad, propel every ship, heat every store and produce every article manufactured by machinery in the United States.

"It will not be long before we can transmit that power under quite practical conditions, by means of wires with the alternating system, over distances as great as a thousand miles. Engineers now object to the use of very high pressures which would be necessary in such transmissions of power. But I believe the time will come when we shall transmit that energy without any wire.

"Since I have experimentally proved that we can get back electric impulses over one single wire without any return, we may avail ourselves of the earth as a medium of transmission as one difficult obstacle to overcome. In fact, the only serious objection to this scheme is to find a means to concentrate the energy of vibrations spread over a great area on one spot.

"If this power is to be transmitted across the ocean it will, of course, involve the expenditure of an enormous quantity of energy. It has been suggested that I can produce a set of lenses made of asphaltum or gutta percha or any other good so-called non-conductor of electricity, and can concentrate these rays, or waves, to a focus where their effect would be powerful.

"This plan, if at all practicable, could be applied as well across the Atlantic as it could at shorter distances on land.

METHODS OF PRODUCING LIGHT

"The present methods of producing light are very wasteful. The electric light is a considerable advance over the gas burner, as far as efficiency is concerned; yet even the electric light, as at present produced, is very inefficient. Of the energy of coal we only get about one-third per cent. in light in an incandescent lamp; much more, however, in an arc lamp, because in that lamp we can reach much higher degrees of incandescence and because we have the advantage of an economical combination of carbon and oxygen.

"It is true that in recent years some notable improvements have been made in gas burners, and that, from a theoretical point of view, it is possible that a far more efficient burner than the ones at present in use may be produced.

"Probably the most important problem electricians are considering is the production of electricity by an efficient process from coal or other cheap substance; at least, most engineers have this subject in view. I think it is fully as important, and, in the end, perhaps even more important, to apply our skill in discovering how to transmit power from the waterfalls to any distance, for then we would be able to obtain energy, without consuming any material, and our coal fields and forests would remain untouched, whereas the production or electricity from some material will involve the rapid consumption of that material.

"One of the problems which is of great importance, and the solution of which we are very likely to witness in a

Nikola Tesla.

few years, is the transmission of intelligence to any distance without connection. From present experimental evidence it can be quite safely concluded that an attempt to transmit intelligible sounds through the earth from here, for instance, to the European continent without any cable will succeed beyond a doubt. But it is a question whether such a method, which I have advocated for two years, would be available for all purposes, such, for instance, as the use to which the Commercial Cable is put.

"In that case it is questionable whether the scheme would be practicable. But one thing is certain, we will be able to transmit universal time all over the earth, and also be able to send in the same way very important short messages from centre to centre.

"Electricity is becoming more and more an important factor in our daily life, and more and more closely connected with our comfort. I think, after a considerable lapse of time, it will become practically necessary for our existence. For instance, there is the question of light. The advantages of the electric light are so great that even with the present wasteful methods we have been able to succeed in making practical use of it.

"But what will be our success when we shall be able to produce a hundred times as much light as we do at the present day? To do this is merely a question of time. Electric power is obtained by the use of dangerous, cumbersome and complicated appliances. But we have electric machines now which require no attention whatever, and which will in a few years supplant all other motors simply because of their higher efficiency and ideal simplicity.

"Even now the cost is very great. Eventually we will be very likely to be able to heat our stoves, warm the water and do our cooking by electricity, and, in fact, to perform any services of this kind required for our domestic needs.

"It has been said that it will be impracticable to heat our houses by means of electricity on account of the great cost of coal; but, as I have said, we are now looking for other methods of getting electrical energy cheap. Even with the present methods any rich man certainly prefers, instead of a stove in his room, to have it warmed by electricity. The method is expensive, but ideal.

"Electric energy can be applied to bicycles, carriages and all sorts of vehicles. It will certainly be applied to rowboats and will probably be so cheap that any man in ordinary circumstances can own a boat and propel it by this means. It would be a gloomy prospect, indeed, for the world if we did not think that this great power will be used to the advantage of the vast majority of the human race and its benefits will not be confined merely to the wealthy.

INTERESTING EXPERIMENTS.

"I am working on some other lines than those of which I have spoken, and if I succeed in my exepriments they will be of great interest principally to scientific men. They have also a practical bearing upon what newspapers sometimes call the 'burning questions of the age.' These experiments are quite apart from old notions and the lines which heretofore have taken up my attention. I cannot tell how soon I will complete these experiments.

"Most of my experiments heretofore have involved either rapidly alternating currents of high potential, or have reference to these electrical waves which are set up by alternating currents, and which, if very rapid, will not go through electric batteries at all, but will go through the best insulators. If they are less rapid they will go through electrical conductors fairly well.

"I think I have received full praise for the work in which I have been engaged. There are some experiments which I made a few weeks ago in Philadelphia and St. Louis which interested our scientific men. For their benefit I have a technical account of these experiments in preparation which will be published in the future in the scientific journals.

"Some years ago I demonstrated that a lampate filament could be made to glow from a current from a human hand. The light coming from the hand is produced by the agitation of the particles of molecules of the air. I charge my body with electricity, and from an apparatus which I have devised I can make the electricity vibrate at the rate of a million times a second. The molecules of the air are then violently agitated, so violently that they become luminous, and streams of light then came out from the hand.

"In the same manner I am able to take in the hand a bulb of glass filled with certain substances and make them spring into light; I make light come to an ordinary lamp in a similar way, simply by holding it in the hand.

"When I was in London I had the pleasure of performing one of these experiments privately before Lord Rayleigh. I shall never forget the eagerness and excitement with which that famous scientist saw the lamp light up. I can only say that the appreciation of such men amply repays me for the pains I take in working out such phenomena.

TESLA'S TRIBUTE TO AMERICA

"When I arrived upon your hospitable shores I eagerly applied myself to work and to learn, and I have persevered in that course. If I have made any special success in this country I attribute it largely to a feature which is characteristic of both the English and American races; that is, their keen and generous appreciation of any work that they think is good.

"I think this country may well boast of its colleges. Take, for instance, Columbia College, Cornell University, Johns Hopkins University or any of the institutions where nowadays electrical engineers are trained.

A GOOD PROFESSION.

"I consider electrical engineering a very good profession for a young man, but it is a profession which requires considerable exercise of intellect. On account of the fascination connected with the study of electricity the profession draws to its ranks an intelligent class of young men.

"Of course it is probably true that the majority of young men who enter the profession are more or less enthusiastic, but in these days a knowledge of electrical engineering has become almost indispensable for engineers in general.

"Nearly every engineer at the present time follows with great interest its developments. And it is the same with the medical profession, for physicians are realizing more and more that electricity will ply a still larger part than it does in the cure of disease.

"For instance, a great amount of electrical energy may be sent into the body by means of high currents, because the energy is dissipated laterally from the body and is not passed through it in a direct manner as it is when a current of low frequency is used. The feeling produced is somewhat different.

"I have also noted the importance of one being prepared for the shock. If you are prepared the effect on the nerves is not nearly as great as when you are not prepared. With these high alternations one feels but little pain in the central portion of the body. A remarkable feature of such high currents is that you feel a burn the moment your hand touches the wire, but beyond that the feeling is scarcely noticeable. I have received currents as high as 300,000 volts, an amount which, if received in any other way, would instantly kill."

The New Stanley-Kelly Two-Phase Motor System.

It has been known for some time that the Stanley Electric Manufacturing Company, of Pittsfield, Mass., has been engaged in perfecting an alternating current self-starting motor for use on two-phase incandescent lamp circuits in the same manner that motors are now so largely employed on continuous current circuits, and the general public as well as the electrical profession

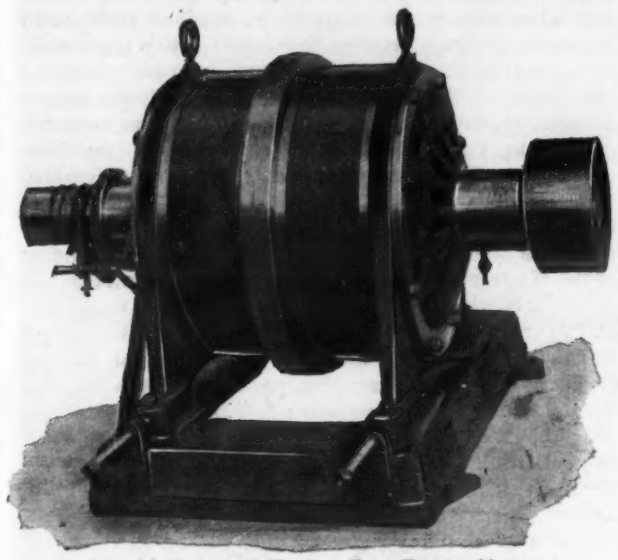


FIG. 1.—STANLEY-KELLY TWO-PHASE MOTOR.

will be pleased to know that not only are the motor and all the details of the system now perfected, but that a large stock of apparatus is actually ready for the market.

The Stanley company adopted the wise plan of perfecting the system to its minutest details, and then subjecting it to a lengthy test by actual use under commercial conditions before placing it before the public; they recognized, no doubt, that any preliminary announcement would have little effect in the face of the failure heretofore, more or less complete, of the many alternating motors too hastily announced as realizing all the conditions of practice.

Some of these motors have been in practical operation, doing work from day to day, for the past six months, and for the past two months in Pittsfield an 80-h. p. two-phase generator has been running in the station of the Pittsfield Electric Company, supplying about 40 h. p. of lights and about 40 h. p. of motors (seven in number in sizes of from 10 h. p. down) in practical use without a hitch or accident of any kind. This, as far as we know, is the first thoroughly practical demonstration of a general distribution of light and power by means of the alternating system, and removes the cause of the reproach to which it has heretofore been subjected in this respect.

The reason that A. C. motors, either for single or multiphase circuits, that have been experimented with, have not been commonly introduced heretofore, is because of the false currents developed by the motors, the inability to develop a good starting torque without making these false currents very excessive, and the impossibility, because of the false currents, to produce a comprehensive system for both light and power fed by the same dynamo and circuits. These false currents have made regulation impossible, and have made necessary generators, lines and transformers so disproportionately large for the work to be done that it has been uncommercial. In a commercial system for wide distribution of light and power throughout a city, motors which take current about proportionate to their load are essential and, in the case of the various multiphase motors, which there has been so much effort to introduce in this country and abroad, this has not been accomplished. Another potent reason why alternating motors have not been introduced in this country has been because the standard of frequency adopted has been 16,000, at which frequency the false currents are much greater than if the frequency had been considerably lower, say 7,000 to 8,000.

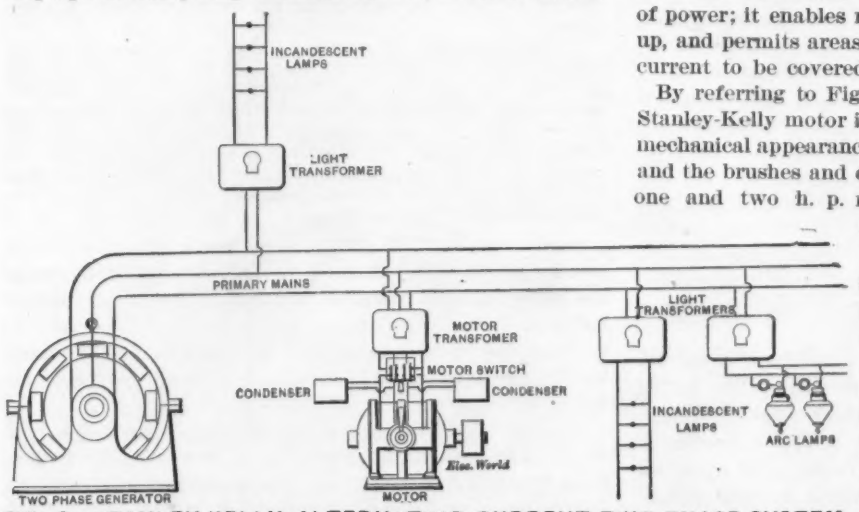


FIG. 3.—STANLEY-KELLY ALTERNATING CURRENT TWO-PHASE SYSTEM.

The object of the Stanley company has been to produce a motor which would be commercial on the standard frequencies used in this country, in order to, in a great many places, simplify the problem of adopting multiphase apparatus, because of the vast amount of money already invested in generators and transformers only adapted for this high frequency. By reason of the condenser and compensating winding of the field, which will be explained later on, the motor works perfectly and commercially on 16,000 alternations. Moreover, the same reasons that make it superior to other motors on 133 p. p. s. will apply with equal force, and give it the lead, when worked on lower alternations.

One of the features of the system is the manner in which it admits of being gradually grafted onto existing alternating systems, merely requiring the addition of a third wire, (which is a very simple matter,) to the circuits from which power will be used. The two-phase generator can be used during the daytime to furnish light and power, and after the use of power is over the three wire circuit can be readily switched onto the ordinary single phase machine at the switchboard if it is desired. The present transformers in use for lighting can be used; all that is necessary being to break one of the present connections to the transformer, and make that connection to the third wire. Where motors are needed a special transformer is put up, with connections made to all three wires. The lighting transformers should be connected about half and half on each side of the central wire, but it is not necessary to balance the system delicately, as, if on one side there is a considerably heavier load than the other, no harm is done. In this respect it is not as complicated or as difficult to keep in balance as the continuous current three wire system, and, in fact, gives no more trouble in operation than the ordinary single phase system. Another advantage is that the total weight of wire necessary in a system of this kind is 25 per cent. less for a given output and line loss than with the ordinary single phase system.

A practicable two-phase system like the present one makes it possible for stations, at comparatively small expense, to add power to their lighting service, no matter where the power is located, and thus get all the benefits of long distance distribution of power in connection with their lighting circuits, without throwing away a lot of

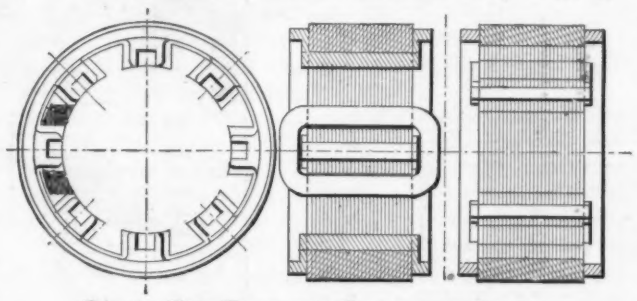


FIG. 4.—END VIEW AND SECTION OF FIELDS

their present apparatus; after the system is once started, as business grows, it will be a comparatively inexpensive matter to change, little by little, everything over to two-phase, where that end is desirable. It would be better, perhaps, for central station companies just starting in to use a lower frequency, say 60 or 65 p. p. s., and it should be borne in mind that the total efficiency of the system with this lower number of alternations would be somewhat better than with 133 p. p. s., although, so far as reliability of operation is concerned, one is equally as good as the other. It is, perhaps, unnecessary to refer to the enormous expansion this system permits to be made over the continuous current system in the distribution of power; it enables new and distant fields to be opened up, and permits areas within the limits of the continuous current to be covered at but a fraction of the expense.

By referring to Figs. 1 and 2, it will be seen that the Stanley-Kelly motor is very compact in form and neat in mechanical appearance. The armature is entirely enclosed, and the brushes and collectors require no attention. The one and two h. p. motors do not require any collecting rings or a starting box, as they may be readily started by a pull of the belt, so that no connections whatever are exposed on them. As there are no adjustments, after a motor is once started it will run always without attention, if once in a few weeks care is taken to fill the self-oiling ball bearings; a motor can, therefore, be fixed in places not readily accessible, or boxed up in a corner and left to take care of itself. In starting the lever shown in Fig. 2 is operated, and in a very few seconds the motor is brought up to speed, when the lever is turned into a position where it short circuits the armature coils and the motor left to itself. Seriously overloading the motor does not burn it out, but simply stops it, a great advantage over the continuous current type. A five-horse power motor weighs 750 pounds, and on the Pittsfield circuit has a speed of 2,000 revolutions at no load, and 1,840 revolutions at full load.

Fig. 3 shows the disposition of the different parts of the system. The generator need not differ in construction from the ordinary alternator, which may be utilized by the addition of another collecting ring, and rewinding the drum with two windings so placed relatively to each other as to develop currents in quadrature. A special dynamo, however, has been designed by Mr. Stanley containing several new features, and will shortly be placed on the market. The lamp transformers are, as stated before, of the ordinary commercial type, and those in connection with the motor do not differ in principle from the usual type.

The motor consists of a laminated drum not differing from the ordinary drum type of armature, in which the wires are imbedded in grooves in the surface, and of two laminated cylindrical fields that have no electrical connection with each other, but from mechanical considerations are joined together. The fields are built up of laminated iron discs, as shown in Fig. 4 and have internal projections or poles encircled by the field coils; the two similar frames of the field are so joined together that the poles are "staggered," those of one field being

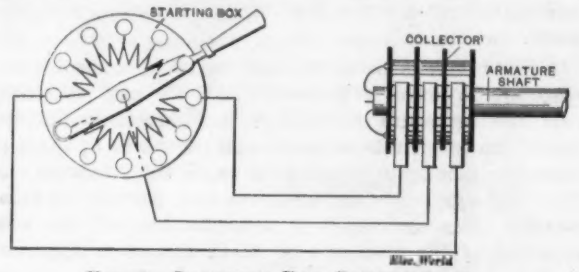


FIG. 5.—STARTING BOX CONNECTIONS.

opposite the spaces between the poles of the other; (in the end view of Fig. 4, the two poles adjacent to the coil shown belong to the other field). The number of poles depends upon those of the generator and the speed desired, the product of the speed by the poles being the number of alternations of the generator. A three-horse power motor has 8 poles, and, on the regular 16,000 p. p. m. circuit, will run at 2,000 revolutions per minute, dropping from 7 per cent. to 8 per cent. at full load.

In the top of each pole is a groove extending its full length, in which is imbedded a copper bar. The ends of the different bars are connected together on each side of the pole by being secured into a ring, so that a current set up in a bar divides at the ring, flows through the bars of the two adjacent poles, and returns by means of the opposite ring. This arrangement is an essential feature of the motor, and is called the "compensator," the action of which will be explained further on.

The armature, which is of the length of the two fields, is wound in as many sections as there are poles in either field, as follows: From the first groove the winding goes to the groove whose distance is the same as that between the outside edges of two adjacent poles, then returns to the inside groove next to the first, and so on until the width of each winding of the coil is equal to the width of a pole, thus leaving vacant an equal space between; after the first series is wound the alternating vacant spaces referred to are similarly occupied by another series. The grooves are of the depth of two wires, and a duplicate of the winding just described is added, which makes the armature electrically symmetrical, as in the ordinary continuous current forms. It will be thus seen that when the armature is in place a coil whose width is covered by two adjacent poles of one field is open

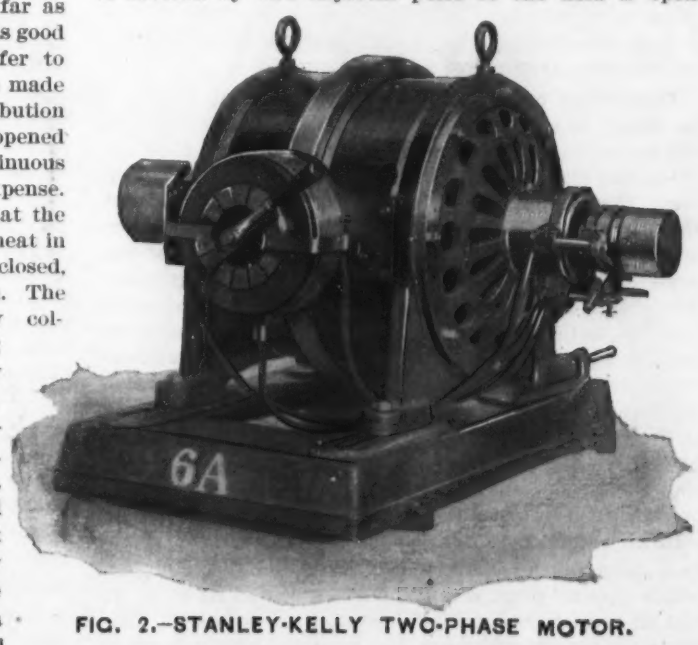


FIG. 2.—STANLEY-KELLY TWO-PHASE MOTOR.

under a pole of the other field, and vice versa. With small motors that can be started by hand, these coils or each of the sections may be short-circuited on themselves, but in the larger size they are joined in two separate circuits, corresponding to the two different windings, and one terminal of each led to a collector on the shaft, the other two terminals being joined together and led to a third collector. The necessity of this will be explained later on.

An explanation of the action of the motor can now be readily followed. When two currents have a difference of phase of 90 degrees, it is readily seen that one current is at its maximum strength when the other is

passing through zero; on the other hand, the latter current has then its maximum inductive action, the rate of change being a maximum when a current passes through zero. If now a pole of the zero circuit (which will have no polarity) is opposed to the central opening in an armature section, its inductive action will produce a strong current in this section, which will also flow over the two poles of the other field, which at this time have a maximum strength due to the maximum current in their coils. This will produce a torque exactly as in the case of a continuous current motor, the condition in regard to the field and armature current being the same. As a coil moves out of this position of maximum torque, its current as well as the strength of the motor poles becomes weakened, but at the same time the second series of coils begins to gather strength, and finally reach their maxima when those in the first exert no torque, and so on. From this it will be seen that one field and one-half of the length of the armature act as a transformer to furnish the current for the other half of the armature, which, with the other field, forms a motor, and vice versa.

Thus far it has been assumed that the armature currents are in phase with their E. M. Fs. and practically that the armature is without self-induction; unfortunately, however, this is not so, and the result of the self-induction that really exists is to cause the armature current to lag and thus not be in the best position to cause rotation. The necessity of neutralization of the self-induction of the armature of A. C. motors is apparent in all types, and this is accomplished in the Stanley motor by the use of the compensating coils or "compensators," the special invention of Mr. John F. Kelly. The reaction of the armature current induces currents in the various circuits of the compensating system, which act opposite to and neutralize its reactive effect. The principle is similar to that employed in the Spencer-Ryan method of counteracting the armature reaction of continuous current machines, by surrounding the armature with a circuit through which the armature current flows, and of such a number of turns as to, by their mutual reaction,

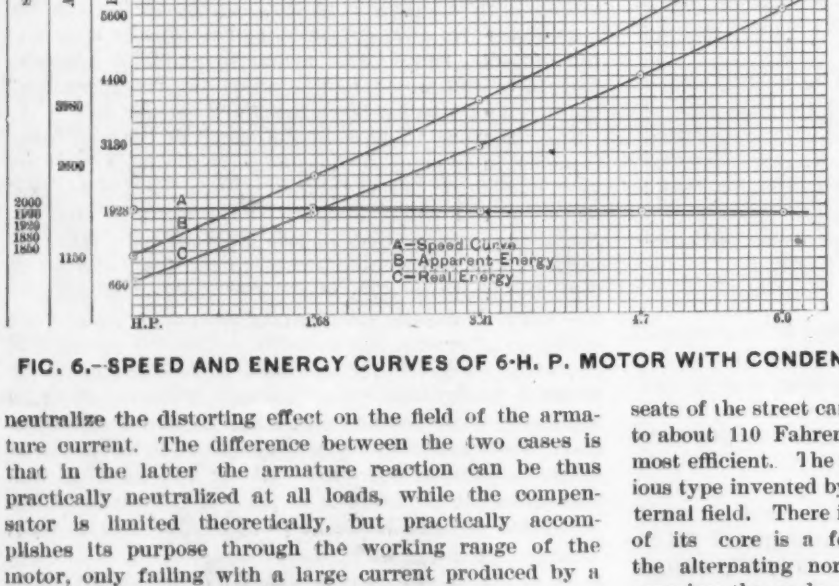


FIG. 6.—SPEED AND ENERGY CURVES OF 6-H. P. MOTOR WITH CONDENSER.

neutralize the distorting effect on the field of the armature current. The difference between the two cases is that in the latter the armature reaction can be thus practically neutralized at all loads, while the compensator is limited theoretically, but practically accomplishes its purpose through the working range of the motor, only failing with a large current produced by a considerable overload or when starting.

This brings us to the starting arrangement, which is necessary to overcome the great flow of current due to the armature being at rest and having no back E. M. F. Were the circuit closed upon starting without a resistance, there would be a large rush of current through the armature coils, and as also at this time the frequency is the greatest in the armature circuits, the lag of the armature current behind its E. M. F. would be greatest. The object, as has been stated before, of the compensating coils, is to correct this lag, but they are not sufficient for the increased current and frequency, so that non-inductive resistances are placed in the armature circuits, which, after a very short period necessary for the motor to get to full speed, are cut out and the armature coils at the same time short-circuited on each other. Fig. 5 shows the connection of the starting box, the resistances of which consist of spirally wound bands of iron ribbon.

In all induction motors of the multiphase type, there is a magnetizing current of considerable magnitude, which does no work, being 90 degrees behind its E. M. F. and in consequence not in a position to do work. This loads up the transformers, the lines and the generator, and, worse, this "lagging" or "false" or "pseudo" current, as it is variously called, increases the reaction of the armature on the field of the generator, so that the capacity is reduced. Since this current is 90 degrees behind the E. M. F., and the current flowing in and out of a condenser is 90 degrees ahead of the E. M. F., this false current can be, and in the Stanley-Kelly motor is, furnished by condensers connected in parallel on each side of the motor. The effect of the condensers is shown by the curves of Fig. 7, which indicate how largely they reduce the volt-ampere or "wattless" component. The measurements for these curves were made by means of a wattmeter designed by the Weston Electrical Instrument Company, which rendered excellent service during the experimental stage of the motors.

The condensers are manufactured by a process and with materials that the Stanley company prefer not to make public. That they are perfectly practicable in use has been shown by the extended test on the commercial circuit in Pittsfield, and we also learn from a disinterested source that they have undergone severe laboratory tests recently, without developing any weakness. Much study has been given by Messrs. Stanley and Kelly during the last two years to the manufacture of commercial condensers, and their achievement in this direction is not the least of their triumphs.

The Waddell-Entz Storage Battery Street Cars.

The Waddell-Entz Electric Company gave several exhibitions during the past week of their new storage battery street cars on the Second avenue line, on which 10 specially designed storage battery cars will shortly be placed, and the line from Ninety-sixth street north exclusively operated by them. A complete electric plant has been installed at the 127th street building of the street railway company, all of the details of which have been carefully worked out, and a most thorough test of the system will be made. The charging plant and storage batteries are almost ready for use, as well as the cars, which will soon be placed on the line. The electric plant consists of two 100-h. p. Worthington boilers, two automatic Ideal engines of 75 h. p., to which are directly coupled two 75-h. p. Waddell-Entz dynamos. On the second floor is a fine traveling crane designed by Messrs. Waddell and Entz and operated by electric power, which is used to hoist the trays of batteries to the second floor, where they are charged; by means of the crane the car batteries can be changed in two minutes. The storage battery is the well known Waddell-Entz zinc-copper alkaline type, which has given excellent results, and notwithstanding its low voltage has less weight per horse power, it is claimed, than the lead type, with much greater durability. The batteries, 144 cells in each, are on two trays which are placed under the seats of the street car after first being heated by steam coils to about 110 Fahrenheit, at which temperature they are most efficient. The motors and dynamos are of the ingenious type invented by Messrs. Waddell and Entz with an internal field. There is a single field coil, and on either end of its core is a four-armed spider, whose ends give the alternating north and south poles; external to and covering the ends of the field pieces is a Gramme ring, which arrangement gives a very compact form to the motor and a large torque at starting.

The field coils and armatures of the two car motors are on separate circuits and the 12-volt car lamps are connected with the field cells, thus avoiding fluctuations in the light. The armature batteries of each motor are in four sets, and by means of the controller worked by the motorman are first placed in parallel in starting, then thrown two in series and two in parallel, and as the speed increases all four are placed in series. For additional speed the field is weakened, there being two points on the controller for the two further changes by this means. In stopping, the field remains on, and the armature is short-circuited: the resulting dynamo action is sufficient to bring the car to a dead stop from full speed within the length of the car.

The motor gears run in oil and are made of a special bronze, the teeth being of the involute form. The motor is mounted on a frame which possesses some elasticity, rubber buffers taking up the shock. The exceedingly smooth action of the car was much commented upon, as well as the admirable control possessed by the motorman. There are six speeds, corresponding to the various combinations noted above, and the action is very smooth in passing from one to the other. In stopping the car within its length there was little shock and no unpleasant noise; we predict that the absence of the buzz and thumping, so disagreeable with many electric cars, will be highly appreciated by the patrons of the road. The cars can run 30 miles without recharging the batteries, the weight of which is about two tons for each car.

The exhibition trials were witnessed by many prominent street railway financiers and superintendents, as well as by a number of technical experts; the former expressed themselves as being particularly pleased with the system, and the latter in addition were open in their praise of the excellent manner in which the details are worked out, indicating a high order of engineering ability.

The entire system is the invention of Messrs. Waddell and Entz, and the electrical equipment was made at the works of the Waddell-Entz Electric Company, Bridgeport, Conn.

Candle Power of the Arc Light.

The question is constantly rising as to what is the commercial candle power of an arc lamp; and there are frequent misunderstandings between the central station superintendent and the consumer on this point. In order to hasten a settlement of this important matter the following communication, dated Chicago, April 17, 1893, has been addressed to Prof. Elisha Gray, chairman of the Committee on Electrical Congresses, World's Columbian Exposition, signed by S. A. Douglas, district manager of the Brush Electric Company; W. H. Harding, manager of the South Side Electric Company; C. D. Crandall, manager of the Western Electric Company; A. K. Gilman, business manager of the Great Western Manufacturing Company; D. P. Perry, manager of the Standard Electric Company; B. E. Sunny, Western manager of the General Electric Company; C. H. Wilmerding, president of the Chicago Arc Light and Power Company; J. P. Barrett, superintendent the Electrical Department of city of Chicago, and Samuel Insull, president of The Chicago Edison Company:

"A great deal of confusion is still caused by the term 2,000 c. p., 1,200 c. p., etc., in referring to arc lights.

"In a good many instances this *commercial* term has been the cause of litigation between electric light contractors and purchasers of arc light apparatus. We beg to refer, in this connection, to a few paragraphs taken from Prof. Elihu Thomson's paper read before the National Electric Light Association, Providence, R. I., February, 1891.

"It is well known that the value of an arc light for general illumination is greatly enhanced by the fact of the distribution of light being mainly in a downward direction in continuous current arcs. This, of course, follows from the fact of the positive carbon crater being above, such crater being the part from which most of the light comes.

"This matter has been quite thoroughly investigated, and many diagrams of distribution are to be found in the literature of the subject, as published from time to time.

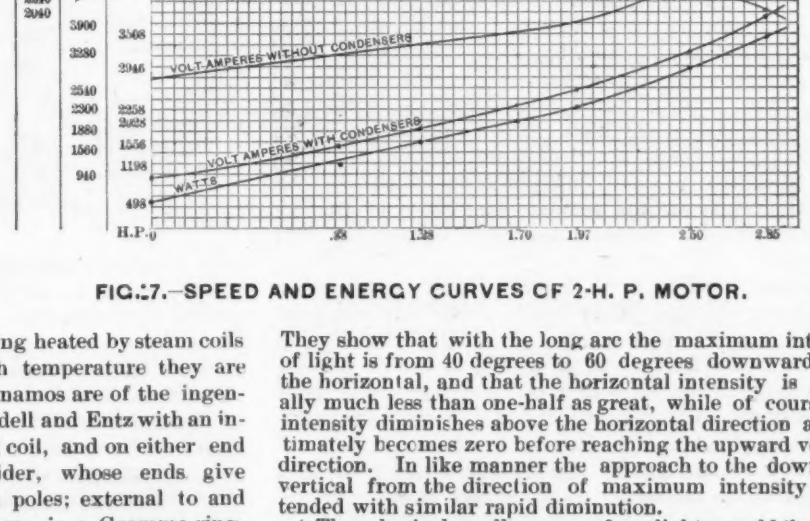


FIG. 7.—SPEED AND ENERGY CURVES OF 2-H. P. MOTOR.

They show that with the long arc the maximum intensity of light is from 40 degrees to 60 degrees downward from the horizontal, and that the horizontal intensity is generally much less than one-half as great, while of course the intensity diminishes above the horizontal direction and ultimately becomes zero before reaching the upward vertical direction. In like manner the approach to the downward vertical from the direction of maximum intensity is attended with similar rapid diminution.

"The spherical candle power of arc lights would therefore be only a fraction of the rated candle power which is generally taken at the maximum light obtainable in the best direction from the particular arc or kind of arc in question.

"For this reason the term 2,000 c. p. arc has little significance as indicating the illuminating power of an arc. It is now generally taken to mean an arc with 10 ampères and not less than 45 volts potential difference between the carbons, or a 450 watt arc. The quality of the carbons will determine whether the 450 watts will be expended in obtaining the most light or not, or whether that light will have a maximum intensity at one angle or another within certain limits.

"As a matter of fact, all attempts made by purchasers of electric arc apparatus to measure what they usually term the actual candle power of arc lamps have been dismal failures, as there are only a few of the best-fitted laboratories in this country in possession of instruments by which they can determine the mean spherical candle power of an arc.

"In this connection we draw attention to an article* of M. Blondel, which appeared in *L'Industrie Electrique*, from which it is evident that it is absolutely necessary to define the general *commercial* terms, 2,000 c. p., 1,200 c. p., etc., in practical electric units.

"It is for the reasons stated above that the undersigned ask you to kindly take this question up at the coming electrical congress during the World's Columbian Exposition, and have the *commercial* terms mentioned above defined as follows:

"'The term 2,000 c. p. arc to mean an arc produced by 10 ampères and 45 volts potential difference between the carbons, or a 450 watt arc. The candle power of arcs produced by currents of more or less ampères or more or fewer volts difference of potential to be rated proportionally.'

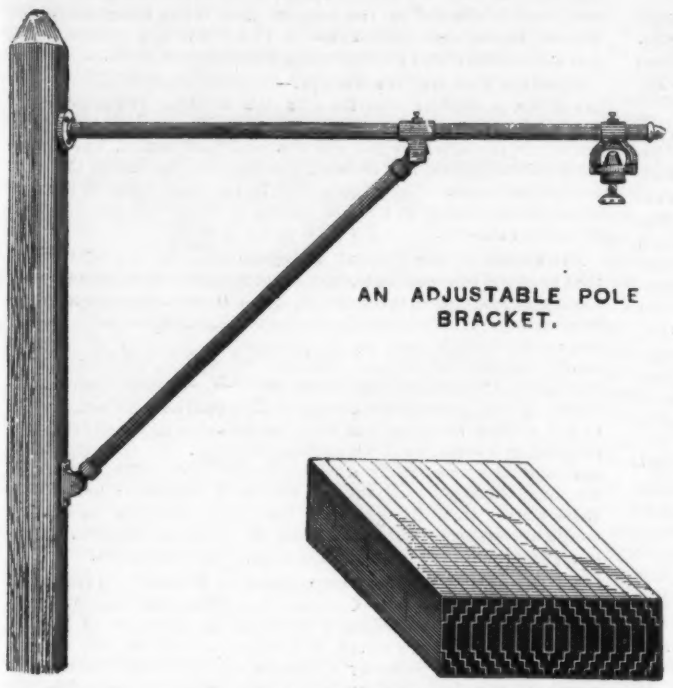
"Such a definition would at once call a halt to all dis-

*See THE ELECTRICAL WORLD, April 22, 1893, p. 300.

putes on this question, and would enable every station superintendent, by simply employing a standard ampèremeter and a standard voltmeter, to determine whether or not the electric contractor has fulfilled the conditions of his contract as to candle power or not."

An Adjustable Pole Bracket.

We illustrate a new adjustable pole bracket designed for bracket line construction for suburban street railways or for centre pole construction in crowded portions of cities. It is made of 1¼-inch pipe with special castings and fittings, and the manufacturers, the Creaghead Engineering Company, of Cincinnati, make special claims as to stiffness. The upper and lower ends of the brace, supporting the arm,



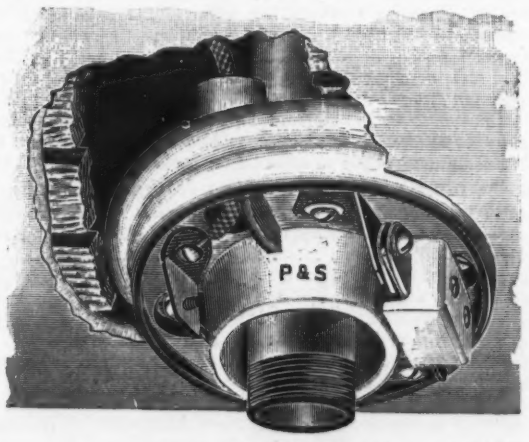
AN ADJUSTABLE POLE BRACKET.

are provided with hooks, which engage in special castings. The use of these hooks makes a bracket which is very easily put together, as bolts are not required in either end of the brace. The bracket arm is made six feet long, or longer if desired. A pole bracket insulator, made to fit 1½ inch pipe, completes the bracket.

This bracket has commended itself to practical street railway men who have examined it, and has already come into considerable use.

P. & S. Combination Fixture Cut-Out and Outlet Insulator.

The proper insulation of outlet wires has heretofore been difficult. The wires are likely to be displaced by the lathers and plasterers, and in many cases leakage through the plaster to the gas pipe on account of defective insulation occurs. As the inspector can only see that part of the wires which projects through the plaster, he has to "trust to luck" for that which is concealed. To overcome these difficulties and make the outlets absolutely safe, Pass & Seymour, Syracuse, N. Y., have devised a combination fixture, cut-out and outlet. As will be seen by the cut, it is fastened to the lathing, and when the plaster is put on it projects slightly through it. The wires pass through holes



P. S. COMBINATION FIXTURE CUT-OUT AND OUTLET INSULATOR.

in the china cut-out, and it is impossible for them to touch either the gas pipe, lath or plaster. It is fitted with brass work for connecting wires and fuses, and is furnished either with fuse plugs, which cover the fuses, or it may be fused in the ordinary way. Pass & Seymour also make small curved tubes for outlets, which effectually insulate the wires from gas pipe, lath and plaster. They are fastened to the pipe by tape, as shown by the accompanying cut. Unlike the tubes made of fibre and the various compounds, these china insulators cannot be bent out of shape, nor do they deteriorate by age. They are not affected by the plaster, are impervious to moisture, absolutely fireproof and possess exceedingly high insulating properties.

The Milwaukee Commutator Brush.

The Milwaukee commutator brush, manufactured by the Wisconsin Electrical Construction Company, 412 Broadway, Milwaukee, Wis., is shown in the accompanying illustration. The white lines on the face and the black lines on the side represents sections of pure copper electrolytically deposited on strips of composition shown by the black lines on the face and white lines on the side. The exterior of the brush is coated with pure copper which binds the copper and composition strips together. The composition is composed of graphite (one of the most perfect lubricating compounds known), carbon and a scouring or cleaning substance. The copper furnishes the conductivity, the graphite the lubrication, and the scouring substance the cleansing properties of the brush. The combination of the

THE MILWAUKEE COMMUTATOR BRUSH.

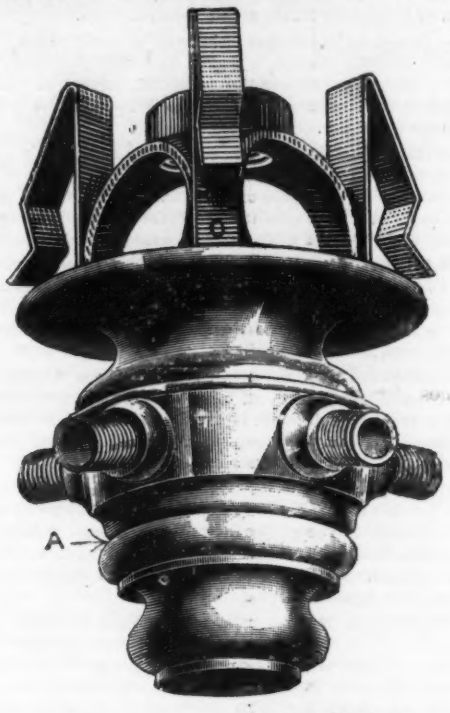
various ingredients produces a brush which three years of practical test under all conditions shows to unite in itself all the requisites above named.

It is claimed that by the use of this brush the life of any commutator will be more than doubled, that it will run without heat or sparking, that it will keep the commutator brightly polished and not cut grooves or ridges in its face, and that it will save the necessity of frequent adjustment of the brushes and do away with all annoying breakdowns.

These brushes are made in all sizes to fit any pattern of radial brush holders; they cannot be used with the old style tangent holders. A new universal holder is being prepared which in its various sizes will fit nearly all dynamos and motors.

The I. X. L. Cluster Ball.

The I. X. L. cluster ball, shown in the accompanying illustration, and which is manufactured by D. J. Hauss, of Cincinnati, O., has some interesting features. The body of the cluster is made of spun brass and is gen-

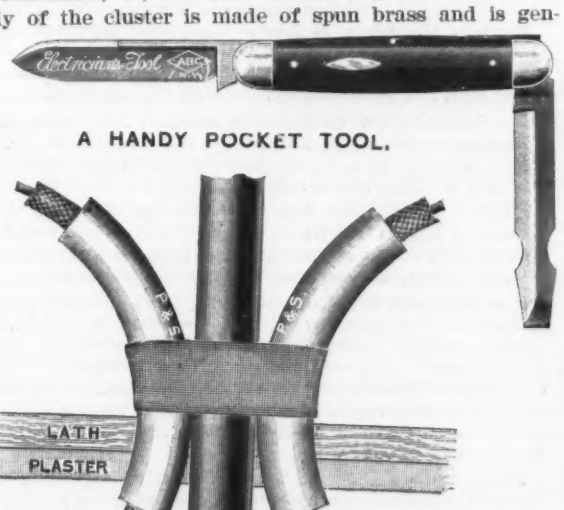


THE I. X. L. CLUSTER BALL.

erally provided with from three to eight nipples, but can be furnished with a larger number if necessary. The top carries a shade holder which is arranged so that a shade designed to fit a 3¼ inch holder can be slipped over. The cluster separates at the point A so as to facilitate wiring. This cluster forms a very handsome electrolier for street railway cars, as well as for ordinary house lighting.

A Handy Pocket Tool.

A screw driver and a knife are absolutely essential for every one who is in any way actively connected with any of the electrical trades. We have all been in the position where we were shown some new device put together with screws, and we have hunted through our desks and our pockets for a screw driver with which to get at the insides of the invention, but we have had to use a flat key or knife blade for want of the proper article.



A HANDY POCKET TOOL.

The accompanying cut shows a very handy pocket tool, recently placed on the market by Alexander, Barney & Chapin, of New York, which is gotten up in three different styles. One has two blades—an ordinary knife blade and a combination screw driver and knife blade, which can be used for stripping wire, etc. Another style has only the combination screw driver and knife blade, and the third style has a screw driver only. These tools are no larger in size than an ordinary pocket knife.

Gem Blow Pipe Torch.

The accompanying illustration shows something new in the way of a blow pipe torch brought out by the Burgess Soldering Furnace Company, Columbus, O. The reservoir is made either of copper or IXXXX. tinned steel, and is protected by an outside Russia iron case, which not only makes it attractive but durable, and protects the reservoir from abuse. The burner, it is claimed, is the most powerful and durable ever used, as it is en-

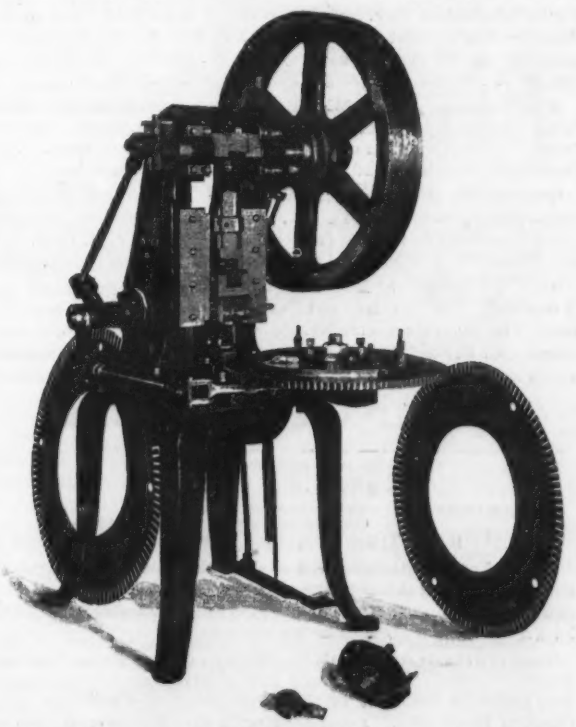
THE GEM BLOW PIPE TORCH.

cased with cast iron, which prevents the brass parts coming in contact with the flame, and crumbling or burning off; it will also be noticed that it is equipped with the improved air faucets together with the black rubber bulbs, which are considered more durable and cannot get out of order, like the air pumps so commonly used.

The regulating device is equipped with a stuffing nut and wheel (instead of ring as shown in cut), with a stop on the spindle so that a full flow of gas can be obtained without opening the valve three or four turns of the wheel.

Bliss Press with Automatic Index Feed.

This machine, which is manufactured by the E. W. Bliss Company, 12 Adams street, Brooklyn, N. Y., is



BLISS PRESS WITH AUTOMATIC FEED INDEX.

especially designed for cutting the notches in the circumference of armature discs for electric motors and generators. The disc is securely guided and clamped on the revolving plate, which at its lower edge has as many teeth as there are notches in the circumference of the disc. The operator starts the machine by putting his foot on the treadle, causing the disc to revolve one notch after each stroke of the cutting punch. When the last notch is cut he releases the treadle, which causes the machine to stop ready for the introduction of another disc. The machine is adjustable in diameter from 10 inches to 34 inches, and more, if required. The weight is about 1,700 pounds.

NEW INCORPORATIONS.

The Coleman Battery Company, Chicago, Ill., capital stock $25,000, has been formed to manufacture and deal in batteries, etc. C. J. Coleman, C. Odell and C. W. Coleman are the promoters.

The Pekin Rapid Transit Company, Pekin, Ill., capital stock $100,000, has been formed to build and operate an electric street railway. The promoters are W. L. Prettyman, J. J. Read and C. A. Kaichem.

The Chicago Metropolitan Gas Company, Chicago, Ill., capital stock $5,000,000, has been formed to manufacture and sell electricity for all purposes. C. S. Owen, M. P. Benson and L. J. M. Malmin are the promoters.

The West Baltimore Land Company, Louisville, Ky., capital stock $300,000, has been formed to erect electric works, railways, etc. T. C. H. Vance, W. L. Haworth, and J. V. Reed, Louisville, Ky., are the promoters.

The Mutual Electric Light and Power Company, Chicago, Ill., capital stock $75,000, has been formed to furnish electric light and power. Chas. D. Wright, Wm. A. Conover, and A. R. Heckman are the promoters.

The Newberry Passenger Railway Company, Williamsport, Pa., capital stock $18,000, has been formed to construct and operate an electric railway. H. R. Rhodes, J. F. Starr and M. K. Speakman are the promoters.

The Courter Electric Company, Cobleskill, N.Y., capital stock $15,000, has been formed to manufacture and use electricity for light, heat and power. S. Courter, J. H. Tator, and L. C. Holmes, Cobleskill, are the promoters.

The Universal Electric Company, Portland, Me., capital stock $500,000, has been formed to carry on a general electric business of all kinds. W. G. Burnham, H. S. Coggin, Boston, and M. S. Kerth, Quincy, Mass., are the promoters.

The Treichler Water and Light Company, Camden, N. J., capital $100,000, has been formed to distribute electricity, etc. N. K. Treichler, Philadelphia, Pa.; B. Smith, Wenonah, and I. Moffet, Glassboro, N. J., are the promoters.

Sachs Electrical Company, Jersey City, N. J., capital stock $100,000, has been formed to manufacture and sell electrical apparatus. The promoters are S. O. Edmonds, P. P. Pope, Brooklyn, N. Y., and G. W. Sessions, Montclair, N. J.

The Commercial Electrical Supply Company, St. Louis, Mo., capital stock $15,000, has been formed to manufacture and deal in electrical supplies. E. Michaelis, A. E. Einstein and R. E. Enstein, all of St. Louis, are the promoters.

The Scranton & Abington Street Railway Company, Scranton, Pa., capital stock $100,000, has been formed to construct and operate an electric railway. The promoters are H. N. Patrick, J. M. Burke and E. C. Dimmick, Scranton, Pa.

The Superior Electric Company, Chicago, Ill., capital stock $300,000, has been incorporated to manufacture and sell electric motors, dynamos, and appliances of all kinds. F. H. Hamlin, D. H. Wilson and J. L. Clark are the promoters.

The De Pere Electric Light and Power Company, De Pere, Wis., capital stock $20,000, has been formed to operate an electric light and power plant. J. P. Dauchan, Wm. Armstrong, C. G. Wilcox and J. S. Chase are the incorporators.

The Union Passenger Railway Company, Williamsport, Pa., capital stock $3,000, has been formed to construct and operate an electric railway. The promoters are H. R. Rhodes, Jas. F. Starr and M. K. Speakman, all of Williamsport.

The Hillsboro Electric Light and Power Company, Hillsboro, Ill., capital stock $18,000, has been formed to operate an electric light and power plant. Wm. Wurdack, H. H. Humphrey, J. J. Frey and Wm. A. Howett are interested therein.

The Montana Telephone Company, Stevensville, Mont., capital stock $30,000, has been formed to operate telephone lines, etc. A. E. Shappee, G. A. Kain, J. D. Miser, Stevensville, and G. W. Dougherty, Corvallis, Mont., are the incorporators.

The Shereden Terrace Passenger Railway Company, Pittsburgh, Pa., capital stock $12,000, has been formed to construct and operate an electric railway. F. W. Hanitch, T. W. Crotzer and R. V. Duncan, Pittsburgh, Pa., are the incorporators.

The Chicago, West Ridge & Waukegan Electric Railway Company, Chicago, Ill., capital stock $1,500,000, has been formed to construct and operate an electric street railway. F. S. Capron, C. Steinbeiss and F. H. Doland are the promoters.

The Hollywood & Grand View Passenger Railway Company, Williamsport, Pa., capital stock $24,000, has been formed to erect and operate an electric railway. J. H. Link, J. B. Coryell and S. Q. Mingle, all of Williamsport, are the incorporators.

The Consumers' Electric and Gas Company of Los Angeles, Los Angeles, Cal., capital stock $1,000,000, has been formed to generate electricity, etc. The incorporators are G. S. Arnold, G. B. Shaffer, Q. J. Wedney and L. E. Fetr, of Los Angeles.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, April 23, 1893.

John Acton, manufacturer of the well known Acton regulators and reducing and steam heating specialties, has removed to large and convenient quarters at 79 and 81 Washington street, Brooklyn, N. Y., where he will continue his business.

Superintendent Frank C. Mason, of the Police Telegraph Bureau, Brooklyn, N. Y., has just received an appointment as first honorary assistant of the Department of Electricity of the Chicago Exposition. Associated with Mr. Mason will be Supt. Elliott Smith, of the New York Fire Telegraph Department, and City Electrician Morris W. Mead, of Pittsburgh, Pa.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., April 22, 1893.

Barrington, R. I., will have an electric light system.

The town of Milford, Mass., has been granted a franchise for electric lighting.

The citizens of Northfield, Vt., are agitating the subject of electric lighting, and the town authorities will probably take action.

There will be a meeting held at Mechanics Falls, Me., to consider what the town will do about putting in a system of electric lighting.

The Norwich Street Railway Company, Norwich, Conn., will extend its line to Yantic simultaneously with the granting of the charter by the legislature.

An elaborate cigar stand has been located on the first floor of the Hathaway Building, Boston, Mass., for the accommodation of the electric smoking fiends who inhabit this building.

The Electric Gas Lighting Company, Boston, Mass., is mailing to its customers its revised catalogue, which contains many illustrations and descriptions of new goods.

The Redding Electric Company, Boston, Mass., have just issued its latest catalogue. It is very neat in appearance, and contains handsome illustrations of the company's various goods.

Pittsfield, Mass.—The majority of the aldermanic committee on electric street railway franchise agreed with the street railway directors recently on a franchise for electric extensions to outlying towns.

The Hammond Cleat and Insulator Company, recently formed to manufacture the Hammond porcelain cleat, is organized as follows: Wm. B. Rand, president; E. H. Crowell, treasurer; offices at 15 Custom House street, Boston, Mass.

The town of Rockport, Mass., recently voted to accept the proposition of the Rockport Street Railway Company, which desires to locate its tracks in the principal streets of the town from the Gloucester boundary line, at Pigeon Cove, to the Gloucester line in the town proper.

The Drake, Payson & Whittier Electric Company, of Providence, R. I., has just opened a handsome store in the Hodges Building for the purpose of handling a full line of general electrical supplies. A large number of their friends assembled at the opening and reported a pleasant event.

Solid Sheet Mica Insulators.—We are just in receipt of the W.T. C. MacAllen Company's Catalogue, which is gotten up in neat pamphlet form, containing descriptions and giving excellent illustrations of their solid sheet mica insulators. These insulators are mainly used for electric railway purposes.

The Bristol, Warren & Barrington Street Railway Company, of Bristol, R. I., recently organized with a capital stock of $100,000, will begin the work shortly on the construction of its proposed railway between the points named. An electric power house will be built in connection with the line.

The City Council of Northampton recently voted the Northampton Street Railway Company a franchise for an extension of tracks and the use of electric power. Stock was purchased by President Olmsted, Treasurer Smith and Stockholder N. D. Winter, of Springfield. The extension and electrical equipment of Northampton will now be hurried forward.

At Medford, Mass., municipal electric lighting was favored by a vote of 16 to 1, in accordance with the communication made by Mayor Lawrence at a previous meeting, wherein it was proposed to eventually connect an electric light plant with that of the water supply. At present the town of Medford is being lighted by the Malden Electric Company, of Malden, Mass.

The Consolidated Electric Light Company, of St. John, N. B., of which Mr. John F. Zebley is president and treasurer, and which also controls the electric lighting as well as the horse railroads of that place, has recently put in an electric road, which began operations on April 1. This road runs through Prince, William, Union, St. James, Main, and other principal streets.

The Neshobe Electric Company, of Brandon, Vt., capital stock $20,000, which was recently organized for the purpose of purchasing the electric light plant owned by F. E. Briggs, has perfected its organization by electing E. D. Thayer president, and E. D. Blackwell, of Montpelier, treasurer. The new company will erect a new electric light station, to be operated by water power.

The Lynn Gas and Electric Company, of Lynn, Mass., recently placed an order for 60,000 pounds of Holmes, Booth & Haydens' celebrated "K. K." wire, through Mr. E. O. Johnson, 620 Atlantic avenue, Boston. The wire is to be used on the extension of its lines to the new station. Since Mr. Johnson has established himself in business, he has received much encouragement from his many friends, who might equally well be styled customers, and his prospects for doing a prosperous business are very favorable.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, April 22, 1893.

Taylor, Goodhue & Ames have been appointed general Western agents for the product of the "Century" factory, including Century line wire, Century insulating paint, and Century insulating tape, and orders can be filled from Chicago stock.

Mr. George Cutter will remove on May 1 from room 329 The Rookery, to Rooms 851, 853 and 855 of same building. The new offices, together with an enlarged storeroom, will enable him to take care of his increasing trade.

Taylor, Goodhue & Ames will move on May 1 to a store on the ground floor at 348 Dearborn street. This company reports that its business has been steadily growing from the start, and is more prosperous than the most sanguine expectations counted on.

The Railway Equipment Company, Pullman Building, Chicago, Ill., is issuing invitations to its friends to make its office, which is directly opposite the new Art Gallery where the World's Fair Congress will be held, and almost directly opposite the main depot for the World's Fair trains, their headquarters during the Fair. It is the intention of the company to keep a directory of visitors and to furnish information and extend courtesies in every way to its numerous friends.

The Ansonia Electric Company, formerly known as the Electrical Supply Company, reports that 200 miles of road have been equipped within three months with its improved appliances.

The Electric Appliance Company, which has taken the agency for the Diehl ceiling fans, has already secured a number of nice contracts for installations of Chicago stores and restaurants. This company has made a number of small improvements in its Acme lamp socket which add to its merits.

The Electrical Installation Company, of the Monadnock Building, Chicago, of which Mr. L. E. Meyers is the leading spirit, is doing a very satisfactory business. It has the contract for four miles of double bracket work and six miles of double track span work for the Calumet Electric Street Railway Company of Chicago. The road now has 42 miles of street railway, and it is thought will soon have about 70 miles additional. The Electrical Installation Company is also building on contract a central station for 2,500 incandescent and 100 arc lights, putting in the steam plant, buildings, poles, line and everything complete.

CLEVELAND, O., April 22, 1893.

An Electric Line between Cleveland and Pittsburgh, it is rumored, is projected. This line, if constructed, will be considerably shorter than any of the existing roads. It is proposed to run at a sufficiently high rate of speed to shorten the time between Cleveland and Pittsburgh to about one hour and thirty minutes.

At the Meeting of the Civil Engineers' Club on the 12th inst, a paper on "Electrical Street Railways" was read by C. F. Uebelacker, a member of the club. The paper dealt first with the commercial side of the question, and secondly with a general explanation of the systems of electrical propulsion at present in use.

The Recent Consolidation of the Broadway and Newburg and East Cleveland roads has set a large number of rumors afloat as a general consolidation of all the electric and cable lines in the city. This rumor has in part been realized, and the Johnson interests are about to be consolidated with those of East Cleveland, Broadway and Newburg. This will bring four companies under the head of The New Cleveland Electric Railroad Company. The exact conditions under which the Johnson company will enter the syndicate are not as yet made public. It is understood that cars from some of the East Cleveland lines will run through to Brooklyn.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, March 29, 1893.

Liverpool Overhead Electric Railway.—A criterion of the success with which the Liverpool Overhead Railway has already met is afforded by the request that it has addressed to the Mersey Docks and Harbor Board to allow it to erect additional stairs at the terminal station at the Herculaneum Dock.

London Electric Railways.—Another electric railway bill has fallen a victim; this time to the unusual combination of dukes, city aldermen and the London county council. The *bona fide* of the promoters of this bill was badly impugned, and apparently the committee was satisfied that they did not intend to do the work themselves. This fact added to the ineptitude of the promoters in proposing to erect a station at Hyde Park corner sealed the fate of the bill.

Finances of the Postal Telegraphs.—In view of the fact that England possesses one of the, if not the most effective and cheap telegraph systems in the world, it is not without interest to ascertain exactly at what cost the nation obtains this service. In 1870 the government bought up the telegraph companies at a cost of something like 7½ millions sterling. Since that date the capital account has been increased to close upon 11 millions sterling, involving an annual interest and charge of £300,000. The telegraph service of the United Kingdom has since its purchase by the government resulted in a total loss of 4½ millions sterling. For the year 1891-92 the total loss was nearly £400,000, though the actual excess of working expenses over income was only £90,000. I venture to think that if these figures were better known to the public they would acclaim with less enthusiasm the ingenious demands of certain gentlemen to still further lower the telegraph tariffs.

National Telephone Company and Electric Traction.—The National Telephone Company was somewhat neatly checkmated recently in an endeavor to secure the insertion of its now well known protective clause, in a bill introduced by the Salford corporation. The tramway clause of this bill simply asked for power to double a line running along a road. Nevertheless, the telephone company wished to have a retrospective clause applying to the whole tramway system of Salford. Rather than submit to this the Salford corporation withdrew the tramway clause, and as it already possesses parliamentary powers to make use of electricity on existing tramways it can do so without the leave of the National company. I am glad to hear that an electric traction association is likely to be formed for the purpose of resisting the demands of the National Telephone Company. If this association succeeds in energizing a powerful body known as the Municipal Corporations Association, and action on behalf of the common welfare is taken by it, it is possible that the overwhelming pretensions of the National Telephone Company may be held within bounds.

News of the Week.

THE ELECTRIC LIGHT.

Delhi, N. Y., has voted $1,000 for electric lights.

Swanton, Vt., has decided to built an electric lighting plant.

Winchester, Ky., will soon call for bids for an electric light plant.

Greenberg, Ind.—The electric light plant is to enlarge its capacity.

Weston (Ore.) has voted to issue bonds and put in an electric lighting system.

Medina and Oberlin (O.) have voted against purchasing an electric light plant.

Greenfield, O., will issue bonds to the extent of $20,000 to pay for an electric lighting plant.

Northfield and Woodstock, Vt., are discussing the advisability of electric illumination.

The Amityville (L. I.) Electric Light Company's plant, which was placed in operation on April 1, was constructed under the direction of J. C. Mills, of the Patchogue Electric Light Company, and Messrs. J. E. Ireland and S. Ketcham, Jr., of Amityville. The cost was about $25,000. The plant consists of two Armington & Sims engines 12″ × 12″, two 85-h. p. boilers of the E. P. Thomson & Co. make, and two 500-light incandescent T.-H. dynamos. The company expects to put in another dynamo in the fall and illuminate the streets of Amityville by arc lights.

Electric Lights from Car Axles.—The Young-Muskowitz electric lighting system for railway trains was tested on the Central R. R. of New Jersey from Newark to Roselle and return on the evening of April 21. The car used was an ordinary passenger coach in which were installed twenty-five 8-c. p. incandescent lamps. The small dynamo furnishing the current gets its power from the axle by a series of sprocket wheels and chain belts. When the train is in motion the lights are supplied directly by the generator to a certain fixed speed. If the speed increases beyond this point part of the current is used to feed storage batteries under the car, which in turn supply current to the lamps when the train is not in motion. The machinery complete weighs about 900 pounds. The system is the invention of Samuel Young and L. Morris Muskowitz, both of Newark, N. J.

THE ELECTRIC RAILWAY.

Olean, N. Y., it is stated, will soon have electric street car lines.

An electric line is projected between Eau Claire and Chippewa Falls.

The Dartmouth & Westport Electric Railway will soon be commenced.

The new street railway plant at Wheeling, W. Va., has been completed, and will be tested immediately.

Rondout, N. Y.—The work of changing the Kingston City Railway to an electric road has been begun.

The proposed electric railway from East Stroudsburg and Wind Gap, Pa., will pass through Portland, Penn Argyl and Bangor.

Lockport, N. Y.—The city engineer is surveying a route for the proposed electric railway, upon which work will commence about the middle of May.

Millville, N. J., has granted a forty-year franchise to the Millville Rapid Transit Company, which will at once begin the construction of an electric road.

The Boone (Iowa) Electric Railway & Light Company will issue $15,000 first mortgage six per cent. bonds to build and equip an electric light and power plant.

The Dayton (Ohio) Street Railway Company is asking for a franchise for the extension of its tracks on a great number of streets, involving the construction of 20 miles of new tracks.

Right of way has been secured, it is reported, for an electric railway between Lancaster and Easton, Pa., and work will soon be begun on the line between Lancaster and Philadelphia, already provided for.

The West End Street Railroad, of Boston, will submit a bill for the construction of an elevated system in Boston and its suburbs. The estimated capital is from six million to twenty-five million dollars.

The Aurora Street Railway Company, of Aurora, Ill., has decided to build an inter-urban street railway to be operated by electricity to connect Aurora and Batavia, covering a distance of bout seven miles.

Newport, R. I.—A charter has been voted for the Newport, Middletown & Portsmouth Electric Railway Company to build a road from Tiverton to Newport, and there connect with the proposed line from Fall River to Taunton.

PERSONAL NOTES.

Prof. A. J. Rogers, of Milwaukee, delivered an interesting lecture on "Industrial Electrolysis" before the engineering students of the University of Wisconsin on April 14.

Prof. A. F. Dolbear, of Tufts College, Mass., at the last regular meeting of the Universalist Club at the Thorndyke Hotel, Boston, delivered an interesting discourse on "Electricity Hereafter," in which he laid down clearly the lines along which progress in the practical applications of electricity may be expected.

Mr. Philip M. Reynolds and Miss Mary B. Gardner were married at the Church of Our Saviour, Longwood, Brookline, Mass., on April 18. The ceremony was elaborate and attended by many society people from Boston, New York and elsewhere. The groom is the well-known treasurer of the Brown Electric Company, and for five years was connected with the Thomson-Houston company. He is the son of Dr. Reynolds, of Boston, and a direct descendant of Paul Revere. On returning from an extensive bridal tour Mr. and Mrs. Reynolds will reside in Milton.

Mr. C. S. Jones, whose death occurred recently at Chicago, Ill., was an old time telegrapher. He was born Jan. 19, 1833, in Southampton, Mass., but in 1848 removed with his father to Hudson, Mich., and connected himself with the South Michigan Telegraph Company, which he served at a number of places throughout the State. Later he was manager of the Western Union Telegraph offices at Buffalo and Albany. After the great fire he went to Chicago, and in 1873 he was appointed superintendent of the telegraph department of the Illinois Central Railroad, which position he held until the time of his death. His popularity was attested by his election as vice-president of the Old time Telegraphers' Association, and afterward as president of the Association of Railway Telegraph Superintendents. His inventive genius expressed itself in a caveat filed for a typewriter, which anticipated by several years the machine of Sholes and Glidden; a switchboard that became quite widely known and used, a dynamo, etc. Mr. Jones leaves a wife and one daughter.

Capt. De Khotinsky.—Owing to the recent lamp decision the Germania Electric Company, of Boston, which was principally engaged in manufacturing lamps, under the direction of Capt. De Khotinsky, has had to abandon its works. Capt. De Khotinsky, whose patents were those under which this company manufactured, is thereby released from his connection with the company; and all rights to his numerous and valuable patents, not only for lamps and details, but also for accumulators, dynamos, processes, etc., revert back to him. With the exception of but a very few of the earliest electricians, Capt De Khotinsky was one of the first in the field of electric lighting. He was the inventor of the multiple arc system of distributing incandescent lamps, a system which is now used all the world over, for which he obtained the famous French patent; it was due to this publication that no United States monopoly patent could be obtained by others. In his earlier work he also was one of the first, if not the first, to run incandescent lamps from transformers and to appreciate the importance of such a system. He has since been actively engaged in the electrical field and ranks among our leading electrical and mechanical engineers. That his patents are of value is shown by the success of his European company. His conscientious work and long experience will render his services of great value to whatever enterprise he may connect himself with in the future.

Mr. Grosvenor P. Lowrey, the well known corporation lawyer, was stricken with apoplexy on Thursday, April 20, and died that night at his home, 121 Madison avenue, New York City. His death was very sudden, as he had been attending to business at his office on that day. Mr. Lowrey was born in North Egremont, Mass., Sept. 25, 1831, and after a common school education in his native town studied law at Lafayette College under Andrew H. Reeder, and was admitted to the bar in 1854. Kansas was made a territory in 1854 and Mr. Reeder appointed its first governor, and Mr. Lowrey became his private secretary. After taking part in the struggle which resulted in Kansas becoming a State, Mr. Lowrey returned East, and later entered the firm of Porter, Lowrey, Soren & Stone, of New York City. In 1879 or 1880 the firm was changed to Lowrey, Stone & Auerbach, under which name it existed up to Mr. Lowrey's death. Mr. Lowrey was connected in a legal capacity with the elevated roads of this city, and took a prominent part in the Edison incandescent lamp litigation. He was an early friend of Edison and the development of the Edison company and the litigation of its patent rights was one of the chief works of his life. He was also for years the general counsel of the Western Union Telegraph Company, the Baltimore & Ohio Telegraph Company and many other corporations. He wrote considerably upon professional subjects. The news of his death was announced in the United States Circuit Court by Elihu Root, and the court adjourned in respect to his memory, as did several other courts in session in New York City.

MISCELLANEOUS NOTES.

The Worcester Polytechnic Institute, Worcester, Mass., has issued its annual catalogue for 1893. This institution now offers a course of electrical engineering of considerable extent, and its laboratory is well equipped for theoretical and practical work.

The Ohio Legislature has passed a bill requiring that all persons, associations or corporations operating street cars shall provide every electric or cable car during the winter months with a screen constructed of glass or other material at the forward end to completely protect the motorman or gripman.

The "Illustrated Buffalo Express," in its fourth annual real estate number, dated April 16, 1893, under the title of "What Electricity Will Do for Us," devotes a large amount of space to the recent novel applications of electricity to practical work, giving numerous illustrations of various pieces of apparatus, a biography and portrait of Nikola Tesla, an outline of the electrical installation at Niagara Falls, and other interesting matter.

License of Telegraph Company by City.—A city ordinance requiring telegraph companies engaged in business within the State in which such city is located, and which have a place of business in such city, to pay a license tax, is valid, in that it can be enforced without interfering with or violating any rights such companies may have under the interstate commerce law. (Moore v. City of Eufaula, Supreme Court of Ala., 11 So. Rep., 921.)

Industrial and Trade Notes.

C. L. Wright & Co. announce their removal to 132, 134, 136 W Fourteenth street, New York City.

The J. H. & D. Lake Company, Massillon, O., is sending to its friends a handsome glass paper-weight showing a cut of its well known friction clutch pulleys.

Brown & Skinner, 19 Liberty street, dissolved partnership on the 29th day of March by mutual consent. Mr. J. R. Skinner will continue to conduct the business at the same address.

Taylor, Goodhue & Ames, Chicago, Ill., report a brisk demand for Wagner power motors. Mr. Wagner's reputation as an electrical engineer is, in itself, a guarantee of the quality of all machinery bearing his name.

The Vilter Manufacturing Company (formerly the Weisel & Vilter Manufacturing Company), of Milwaukee, which manufactures Corliss engines for driving dynamos, has fitted up handsome new and spacious quarters on Clinton street near Beecher, and is now better equipped than ever to fill orders.

Taylor, Goodhue & Ames, of Chicago, Ill., by special arrangement are enabled to offer Okonite wire, cables and cords to their customers with the assurance that all orders can be filled from Chicago stock: this includes Okonite and Manson tapes.

C. E. Woodruff & Co., composed of AndrewShillinglaw, C. E. Woodruff, and Jno. F. Figel, formerly the Globe Supply Company, of 285 Lake street, Chicago, have entered the electrical field as Western agents of the Globe Rubber Company, Bradford Belting Company, and American Circular Loom Company's wires and cables.

Filer & Stowell, the engine builders of Milwaukee, have removed to larger quarters on Beecher street. They are building two large Corliss engines for the Milwaukee (Electric) Street Railway Company, one of which will be set up in a day or two. They also manufacture pulleys, shaftings, etc., and do a general machine business.

The Commercial Electric Company, 113 S. Tennessee street, Indianapolis, Ind., has just made, among other sales, one of one 75-h. p., two 50-h. p. and several 5, 7½ and 10-h. p. machines for a power plant at Buchanan, Mich. This sale was made through the Commercial Electric Company, of Detroit, the agents in Michigan and Ohio.

The Hill Clutch Works, Cleveland, O., recently shipped some of their well known clutches to the Carbondale Electric Heat and Light Company, Illinois Central Railroad Company, Star Electric Light Company, Dubuque, Ia.; the La Crosse (Wis) Street Railway Company, and have a contract for their apparatus to be installed in the Mackaye Spectatorium.

J. W. Parker & Co., formerly of 38 South Fourth street, Philadelphia, Pa., on April 25 removed their business to 41 North Seventh street, Philadelphia, where they will occupy the first floor and basement of a large building, and will act as agents for the Ball automatic engine, the Case vertical automatic cut-off high-speed engine, and several other specialties.

The Turbayne-Tamblyn Company, Detroit, Mich., reports active sales of the Turbayne arc lamp-incandescent circuits. Among recent shipments are 30 arc lamps for Chicago, 10 for Toronto, Can., and a number of smaller orders for other cities. This company is also now manufacturing small fan motors of a new pattern, and is obliged to work night and day to keep up with orders.

The Dayton Globe and Iron Works Company, of Dayton O., has just sold a 45 inch New American turbine with driving gears, shaftings, etc., to the Billings Water Power Company of Billings, Mont.; a 66-inch New American turbine with driving gears, shafting, etc., to the Public Works Company, of Bangor, Me., and a 22-inch special New American turbine to Williams & Grant, of Portland, Oregon.

Mr. Charles D. Shain, 136 Liberty street, New York City, has secured the selling department of the Cutter Electrical Manufacturing Company, of Philadelphia, and has bright prospects for the sale of the Cutter push button switches and other specialties manufactured by that company. These switches are unique in design, handsomely finished, and fitted in every way to fulfill the purpose for which they are designed.

The Ansonia Electric Company, formerly the Electrical Supply Company, of Chicago, has received an order from the Electrical Engineering Department of the World's Fair for three Wirt volt indicators to read to 3,750 volts, and to be used for the testing of circuits during the fair; also an order for volt and ampère indicators of the Wirt type for the Chicago Athletic and the Columbus buildings at Chicago.

The E. G. Bernard Co., of Troy, N. Y., will on May 1 move to its new quarters on Fourth street, where the company will occupy the ground floor front, 65 by 30 feet, as show and sales room. In the rear of this is a room 50 by 30 feet, which will be used for manufacturing purposes. This shop will be equipped with the most modern machinery requisite for the manufacture of the company's specialties.

The Akron Electrical Manufacturing Company, Akron, O., has received a letter from the Akron Engraving Company stating that that company had used one of the Akron motors in its pressroom for over two years, after having tried both steam and water power, and expressing great satisfaction with it. Power is secured from the car line at a moderate expense and two cylinder presses and three platens are operated by the motor.

The contract for the new power house of the Newton & Boston Street Railway, at Newtonville, Mass., has been awarded to Westinghouse, Church, Kerr & Co. The steam pressure will be 130 pounds, using Babcock & Wilcox boilers. The generator room will contain two Westinghouse compound engines, condensing, driving Thomson-Houston multipolar generators. The original installation is for 400 h. p., and the station is to be in operation July 1.

The G. C. Kuhlman Company, Cleveland, O., on account of the large demand for street cars which it manufactures, has found it necessary to build an addition to its shops 60 × 150 feet and two stories high. The company has just finished 20 cars with side doors for the Cleveland Consolidated Street Railway Company, and has 35 more under construction for the same company, and a number for other roads including several of entirely novel design.

Interior Conduit.—It is claimed that of all the buildings under construction in New York City since Jan. 1, for which the architects' specifications name electrical equipment, two only are using other than the interior conduit system. It is estimated that in the remodeled residence of Cornelius Vanderbilt, at Fifty-seventh street and Fifth avenue, over 100,000 feet of the brass covered interior conduit will be used by the Tucker Electrical Construction Company, which has the work in hand.

The Heisler Electric Company, Drexel Building, Philadelphia, Pa., has decided to considerably enlarge the field of its operations and to extend its business beyond that thus far done in the line of the Heisler long distance series incandescent system to a general electrical manufacturing business. With that end in view it has acquired the control of very efficient alternating and direct current apparatus and motors, etc. In order that its name may correspond with the widened sphere of its business the stockholders decided to change the name of the company from the Heisler Electric Company to the United Electric Improvement Company, under which name it will continue to do business.

A Correction.—In THE ELECTRICAL WORLD of April 15, 1893, an extended description, accompanied by several illustrations, was given of the large plant of the Great Western Manufacturing Company, 201-207 South Canal street, Chicago, Ill. The article was headed and the company spoken of as the "Great Western Electric Supply Company." This was, of course, a mistake, as the name of the reorganized company is the Great Western Manufacturing Company. But this company is so well known in every part of the electrical field under the former name that we trust there could have been no doubt in the minds of any as to what organization was meant by the well known name of the Great Western Electric Supply Company.

The works of the Westinghouse Machine Company, Pittsburgh, Pa., have been running for a year with a full night force. The shops are crowded with a large amount of heavy work in addition to their regular line of manufacture. There are now coming through ten 600-h. p. compound engines of which eight are for the Philadelphia Traction Company, for direct coupling to multipolar generators, and two are to fill an order placed by E. D. Leavitt for the Calumet & Hecla mines, to be used in driving electric pumps for mine drainage. The company has just completed the shipment of six 1,000-h. p. engines for the Westinghouse Electric Company, to be used in filling its contract for lighting the World's Fair. These engines are also coupled direct to 1,000-light generators. They stand 18 feet high and make 200 revolutions per minute.

The Johnson Electric Service Company, of Milwaukee of which Mr. Warren S. Johnson is secretary and treasurer, has just moved into a handsome five story brick building just completed for it at 118 and 120 Sycamore street. The heat regulating apparatus of this company has become so well known that the business done in it has rendered the old quarters inadequate. The Board of Education of Chicago puts the Johnson system into every new school under its control. The Government Building in course of construction at Bay City, Mich., will be similarly equipped, as will also a number of prominent buildings in the West. The Johnson Electric Service Company is preparing to put upon the market a dynamo, a motor and an electric light system, which is to be known as the "J. J. J." Prof. Jackson and Prof. Jones being the designers, and the Johnson company the manufacturers, the "J. J. J." is easily accounted for.

Meeting of the Stockholders of the Detroit Electrical Works.—A meeting of the stockholders of the Detroit Electrical Works was held at the office of the company at Detroit, Mich., on April 14th and 15th, 1893. As a quorum was not present the meeting was an informal one and after the presentation of the statements and reports by the general manager and treasurer regarding the financial condition and transactions of the company for the last two calendar years, and up to April 1, 1893, the following resolution was adopted: *Resolved*, That this meeting adjourn to April 24, 1893, at 10 A. M., at the office of the company; that the circular which has been submitted by the informal committee be approved, and that the same, and a copy of the financial statement and of the recapitulation of the balance sheet of April 1, 1893, be sent to stockholders; and that the directors operate the works as long as practicable with the funds on hand or as may be supplied, and that when the same are exhausted its works be closed down.

The Electric Selector and Signal Company, 45 Broadway, New York City, will make at the World's Fair, in the Department of Electricity, space U 19, a complete exhibit of the principle of individual electrical selection in its several applications. The space allotted to the company is a frontage of 50 feet on the main balcony, thus affording ample room for the display of its specialties. There will be shown in operation, on a scale and under the conditions of every-day practice, a number of railroad semaphores and train order signals, six telegraph stations, six arc lights, several groups of incandescent lamps, four electric motors and a telephone circuit with four or five stations. At one end of the space will be a stand representing a central light station at which will be located the transmitter for cutting in and out the electric lights and motors, and at the other end will be a similar stand representing a railroad train dispatcher's office from which the various signals and telegraph stations will be controlled. The instruments and appliances, while of standard pattern, have all been finished ornamentally and all the wood work will be of natural varnished wood, thus heightening the effect, and making a display which it is believed will be as attractive to the casual visitor as it will be interesting to railroad and electric light men.

The E. P. Allis Company, of Milwaukee, Wis., recently shipped 70 engines in 66 days, but found that it still was 123 engine behind its orders. It has just sold five 500-h. p. compound condensing engines to drive Westinghouse dynamos for the Louisville Electric Light Company, also a special pumping engine for handling the condensing water. The Allis company is also building two 500-h.p. engines, for the Louisville Electric Street Railway Company; four 600-h. p. compound condensing engines for the Baltimore Terminal Company (the tunnel scheme in which electric locomotives are to be used); one of 500-h. p. for the Superior Water, Light and Power Company; one of 600-h. p. for the Lynn, Mass., Gas and Electric Light Company; three of 800-h. p. for the Cass Avenue Fair Grounds Railway, St. Louis; two of 500-h. p. and one of 300-h. p compound condensing for the Anderson (Ind.) Electric Street Railway; also a 1,500-h. p. triple expansion engine for the Narragansett Electric Light Company of Providence, to drive two large Westinghouse generators. The armatures are mounted on the main shaft of the engines for the Narragansett company, the Louisville Company and the Cass avenue company.

The Ball Engine Company, Erie, Pa., reports the following recent shipments, and states that its already large capacity is overcrowded with work: Western Light and Power Company, Chicago, Ill., one 300-h. p. simple engine; T. H. Electric Light and Power Company, Quincy, Ill., one 350-h. p. cross compound; Ann Arbor

Electric Light Company, Ann Arbor, Mich., one 300-h. p. cross compound; Alameda Street Railway Company, Alameda, Cal., two 150-h. p. tandem compounds; Tampa Street Railway Company, Tampa, Fla., one 200-h. p. cross compound; Water, Light and Power Company, Nebraska City, Neb., one 100-h. p. tandem compound; Niagara Falls Street Railway Company, Niagara Falls, N. Y., one 130-h.p. simple engine; Pennsylvan a Salt Manufacturing Company, Natrona, Pa., one 70-h. p. simple engine; Shoenberger & Co., Pittsburgh, Pa., one 80-h. p. simple engine; Gallatin Light, Power and Railway Company, Bozeman, Mont., one 150-h. p. simple engine; Hotel Plaisance, World's Fair, Chicago, one 100-h. p. simple engine; F. W. Wheeler & Co., electric lighting on steamers, three 25-h. p. simple engines; Cienfuegos, Cuba, one 60-h. p. simple engine; Everett Street Railway Company, Everett, Wash., one 200-h. p., one 150-h. p. and one 125-h. p. cross compound; Intermountain Electric Company, Salt Lake City, Utah, one 130-h. p. simple engine; W. H. Kib'inger, Auburn, Ind., one 125-h. p. simple engine; Cohasset Electric Company, Cohasset, Mass., one 80-h. p. simple engine.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Oil Filters for sale cheap. Prices on application to Purity Oil Filter Manufacturing Company, 901 Water street, Pittsburgh, Pa.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Bedell & Crehore's Alternating Currents of Electricity.—What is said of it: "The work of Drs Bedell and Crehore constitutes the most complete and didactic treatment thus far made. . . . All the demonstrations are satisfying from their simplicity and rigourness."—*La Lumière Electrique.* 'This book will probably be for years a standard textbook on the subject."—*Prof. R. A. Fessenden, Purdue University.*

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

UNITED STATES PATENTS ISSUED APRIL 18, 1893.

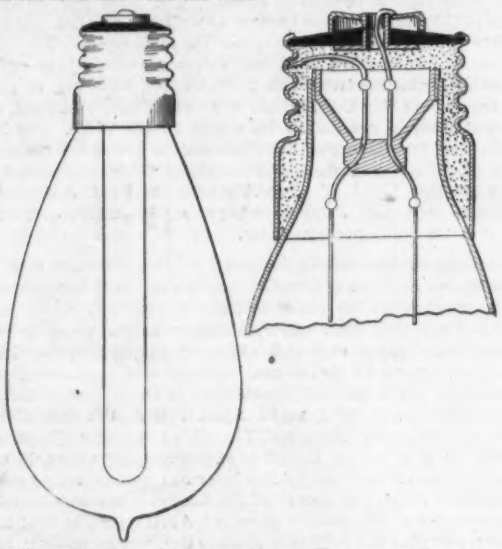
[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

495,513. Insulated Pipe Joint or Coupling; Thomas J. Pierce, Philadelphia, Pa. Application filed Aug. 19, 1892. An insulating joint or coupling consisting of two separable parts each having a d pression, which depressions firmly hold or secure an insulating block surrounded by additional insulating material, in combination with a collar uniting said parts together, and insulated from the upper part.

495,538. Dynamo Electric Machine; Thomas L. Willson, Brooklyn, N. Y. Application filed March 8, 1890. The combination of an armature consisting of a cylindrical iron core overlaid with insulated longitudinal conducting bars, a field magnet having a plurality of poles exterior to and facing the arm ture, so that as the armature turns its bars pass through two successive fields of alternately contrary polarity, two or more pairs of commutator brushes to each field, the two brushes of each pair arranged to make simultaneous connection with the opposite ends of the armature bars passing them and the successive pairs of brushes arranged to make successive connection with the armature bars whereby the bars in their passage through each successive field are successively included in two or more brush circuits, and conducting connections from brush to brush, adapted to join the armature bars in one or more external circuits, and the conducting connections extending between a negative brush of one field and a positive brush of another field whereby the brushes are connected serially and the circuit is completed around the armature.

495,547. Combined Electric Motor and Driven Machine; Rodolphus Fuller, Detroit, Mich. Application filed March 31, 1892. In a combined motor and fan, the combination with the frame of an electric motor, an armature on the shaft, a fan on the shaft, magnets for the motor arranged on the suction side of the fan, and a keeper forming a structural part of the machine.

495,552. Insulator; Louis Hills, New York, N. Y. Application filed Aug. 22, 1892. In an electric wire clamp, the combination of the forked metal base having exterior screw thread, the wire bearing block of insulating material supported in the form, and the clamping nut of insulating material adapted to screw upon the fork and bend the wire.



No. 495,620.—INCANDESCENT ELECTRIC LAMP.

495,561. Commutator for Dynamo Electric Machines or Motors; Buchanan S. Paterson, Gateshead, England. Application filed Aug. 16, 1892. A commutator for a dynamo electric machine or mo or constructed with keyways and with keys composed of pieces of mica placed radially within said keyways.

495,562. Field Magnet; Frank A. Perret, Springfield, Mass. Application filed Oct. 28, 1892. In a dynamo electric machine or motor, a field magnet having an iron core constructed in two parts, each part provided with a polepiece, and the parts being connected together by a wedge or V-shaped joint.

495,564. Electrical Bell; Henry B. Porter, New York, N. Y. Application filed Oct. 26, 1891. A helix having its core projecting from its ends, said core being formed of an outer covering having an interior formed in two horizontal sections, one of soft iron or similar suitable material, and the other of wood or other non-conducting material.

495,582. Ground Generator of Electricity; Michael Emme, Oakland, Cal. Application filed Aug. 29, 1892. A ground generator of electricity comprising a series of galvanic couples embedded in an electrolytic medium composed of earth mixed to a pasty consistency with a suitable excitant and filled in holes formed at intervals in the earth.

495,587. Ship's Log; Charles F. Holt, New London, Conn. Application filed July 25, 1892. In a speed indicator, in combination and with an electrical circuit containing distance registering mechanism, a battery and an interposed bar of resistant material traversed by a contact pointer and a submerged drag, connected with and controlling the traverse movement of said pointer.

495,601. Electric Arc Lamp; Frederick T. Schmidt, Bradford England. Application filed Aug. 24, 1892. In combination, in an arc lamp, the upper and lower carbon holders, the pulley, the suspending cord connected to the carbon holders and passing over the said pulley, the solenoid, the lever connected to the core thereof, and the brake hand connected to the lever and embracing the pulley, said brake hand having an enlarged portion to engage the pulley.

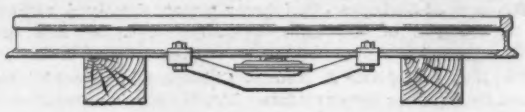
495,608. Magnetic Ore Separator; George G. Crosby, New York, N. Y. Application filed Jan. 27, 1892. In a machine for separating magnetic from non-magnetic substances, the combination with a magnetized drum, of rollers, an apron and an arm or beater.

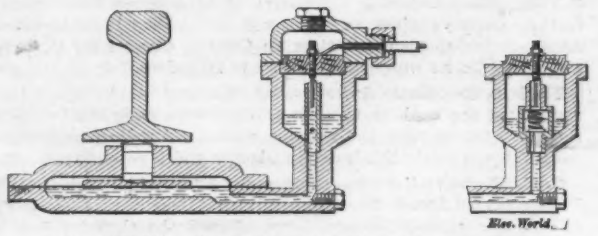
495,615. Crossover Switch for Electric Railways; Frank B. Rae, Detroit, Mich. Application filed April 11, 1891. In a crossover, the combination of a plate to which the trackpieces of one of the conductors are connected, of a second plate adjustably connected therewith, and carrying the insulators to which the trackpieces of the other insulators are connected.

495,620. Incandescent Electric Lamp; Eugene W. Applegate, Chicago, Ill. Application filed Jan. 8, 1893. In an incandescent electric lamp, the combination of an inclosing bulb or globe, a plug or stopper adapted to fit the neck of said bulb or globe, and a homegeneous separating strip or ring of metal or metallic alloy, which ring or strip is interposed between the said plug or stopper and bulb or globe, so as to separate them at the surface of sealing and yet form with them a complete and practical inclosing air-tight chamber. (See illustration.)

495,626. Electric Welder for Wire Fence Machines; John D. Curtis, Worcester, Mass. Application filed Nov. 2, 1892. In a machine for making wire fencing, the combination with the wire feeding mechanism of an electric welder intermediate of the wire feeding mechanism and the wire supply mechanism, whereby unbroken lengths of wire may be supplied to the wire feeding mechanism.

495,638. Secondary Battery; Leslie B. Rowley, Ashland, Wis. Application filed Sept. 22, 1892. A secondary battery electrode comprising in combination a supporting element consisting of a series of supporting tubes, molded, cast or otherwise





No. 495,674.—BAIL CIRCUIT CLOSING CONTACT.

formed into a homogeneous integral structure, a series of electrical conductors connected together and located respectively in said tubes, and active material in said tubes surrounding said conductors.

495,647. Electric Arc Lamp; William A. Turbayne, Detroit, Mich. Application filed July 1, 1892. In an arc lamp, the combination with the gravity feed carbon holder, gravity clutch and the lever adapted to move said clutch to clamp and lift said feeding carbon holder, of an electromagnet or solenoid in shunt circuit adapted to actuate said lever to relieve said clutch, a weight on the opposite end of said lever adapted to actuate said lever to clamp and lift said clutch, a pivoted armature, an electromagnet and a cut-out in the shunt circuit operated by the armature and electromagnet or solenoid in the lamp circuit.

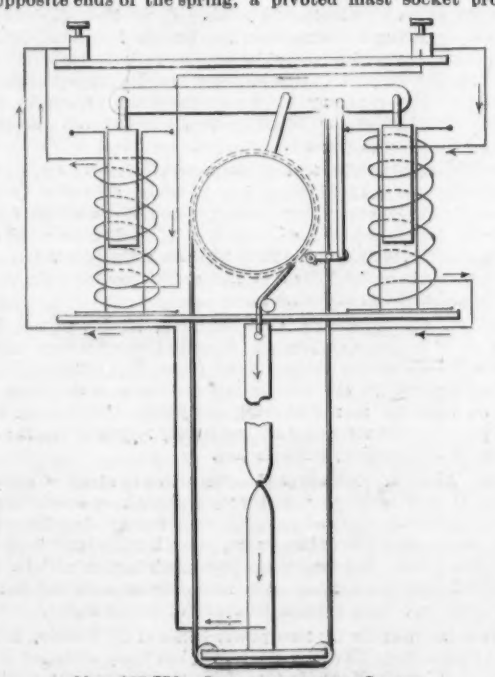
495,649. Electric Arc Lamp; Charles F. Adams, Morrison, Ill. Application filed Dec. 19, 1892. A feed mechanism for arc lamps, comprising a primary current coil having a movable core, a secondary or derived current coil having oppositely directed wires and having also a movable core, and a movable frame actuated by the core of the primary current coil, a rocking shaft actuated by the core of the secondary current coil, a disc or wheel carried by and independently revoluble upon said shaft and having an insulated section, a screw rod carried by the movable frame, an electrode carrier having arm for engaging with said screw rod, and a pawl and ratchet mechanism operatively connected to the screw rod and also to the rocking shaft.

495,674. Bail Circuit Closing Contact; Friedrich von Hefner-Alteneck, Berlin, Germany. Application filed Jan. 18, 1893. In an electric circuit closing device, the combination with fluid-charged communicating chambers or vessels, one having a flexible diaphragm and the other having an electrical contact, of means for prolonging the electric circuit through the fluid and contact. (See illustration.)

495,676. Electric Lamp; Tobias Hudson, Baltimore, Md. Application filed Oct. 7, 1892. In an electric lamp, the combination of a base having a chamber for a cut-out, and a socket on the outer side; a stem having one end which fits detachably in said socket, said stem having a socket at the opposite end; and a globe provided with an end which fits detachable in said socket on the stem.

495,692. Trolley Wire Finder; Charles G. Cleminshaw and Wm. H. Brandt, Troy, N. Y. Application filed June 22, 1892. The combination with the trolley and trolley arm of an electric car of a wire finding finger supported by the trolley arm in the plane of the trolley groove and normally located below the top of the trolley, and means for projecting the finger above the trolley.

495,695. Electric Railway Trolley; Wm. Duncan, Allegheny, Pa. Application filed July 20, 1891. In a trolley for electric cars, the combination of a spring, crossheads arranged at opposite ends of the spring, a pivoted mast socket provided



No. 495,772.—ELECTRIC ARC LAMP.

with arms connected to said crossheads, and abutments arranged to operate in connection with the arms of the pivoted socket and the connections between them and the crossheads for increasing the inward traverse of the latter.

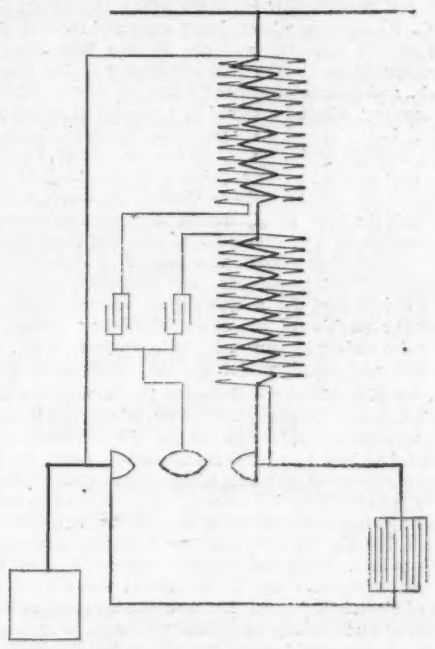
495,714. Lightning Arrester; Elihu Thomson, Lynn, Mass. Application filed Aug. 5, 1892. The combination with an electric line, a dynamo machine or motor connected to such line and grounded at its other terminal, of a lightning arrester placed in a shunt around the dynamo from the line to the wire or connection leading from the dynamo to the ground, said lightning arrester being provided with means for preventing the continuance of a discharge to ground from line after the passage of the static discharge due to lightning.

495,738. Electric Rotary Drilling Machine; Robert M. Jones, Salt Lake City, Utah. Application filed June 30, 1892. In a rotary drilling machine, the combination with the frame and an electric motor mounted therein, of the fluid pressure cylinder secured at one end to the frame and axially aligned with the tubular shaft of the motor armature and provided with a valve controlled inlet at its outer end, the tubular drill shaft within said cylinder and splined in the armature shaft, the drill, the piston in the cylinder and collared on the drill spindle, said piston having packing between its outer face and the cylinder and between its inner face and the drill shaft, a tube connected at one end with a branch of the fluid inlet to the cylinder and extending into the inclosed outer end of the drill shaft, a valve forregulating the entry of water to the outer end of said tube, and a relief valve on said fluid pressure cylinder.

495,744. Method of Indicating Telegraphic Messages; Joseph Levi, New York, N. Y. Application filed Jan. 16, 1893. The method of indicating telegraphic messages, consisting in the transmission of words and the use of the consonants of those words in connection with a key or prearranged meaning to be given each consonant, so that the receiver by eliminating the vowels of a word understands the message by the key.

495,770. Time Indicator and Signal for Races; Alfred Bartlett, Auckland, New Zealand. Application filed March 24, 1892. In an apparatus for starting races and indicating the results of the same, the lever having a cord and arm.

495,772. Electric Arc Lamp; E. E. Beauvalet and L. C. Beauvalet, Paris, France. Application filed July 11, 1892. In combination, the carbon points and their holders the solenoids, the lever controlled thereby, the wheel having a ratchet wheel, the pawl and its lever for operating the same, the cord connecting the carbon holders with the wheel, the brake, both the said brake and pawl lever being connected to the lever to which it is secured. (See illustration.)



No. 495,853.—LIGHTNING ARRESTER.

495,782. Electric Shoe Sole; Rufus E. Carnes, Winfield, Ala. Application filed Dec. 22, 1892. The combination with a shoe, of the inside electric conducting sole, the electric conducting points formed upon the bottom of the said sole, and the electric wire stiching forming additional conducting points in contact with the inside.

495,853. Lightning Arrester; Elihu Thomson, Swampscott, Mass. Application filed Feb. 15, 1892. The combination of a protective spark gap or set of gaps, and means controlled by the discharge current for breaking down the dielectric in the gap by the momentary exhibition thereat of a potential or electric strain greater than that which would be due to the discharge itself. (See illustration.)

495,861. Electric Belt; George F. Webb, Cleveland, O. Application filed Dec. 16, 1892. The combination with the belt and the battery carried by the belt of an abdominal supporting strap adjustably secured to the back portion of the belt, and an electrode carried by the strap and connected with the battery.

495,913. Danger Signal for Railway Crossings; James S. Savage, Detroit, Mich. Application filed June 4, 1891. In an automatic danger signal, the combination of an electromagnet having a pivoted armature, a weighted arm and rack attached to said armature, the pinion engaging with said rack, the pendulum rack and pinion engaging therewith, and the vibrating arm carrying the swinging signal at its free end.

495,929. Electric Cigar Lighter; Wm. Carter and Charles F. Willey, Louisville, Ky. Application filed July 18, 1892. The combination of a suitable support having a converter or transformer of electric energy secured thereto.

495,932. Electric Lighting System; Henry Edmunds, Jr., London, England. Application filed Oct. 19, 1892. In combination in an electric lighting system, the main circuit, the pilot lamp therein, the bracket lamp or lamps detachably connected to their supports, and the cut-out for the pilot lamp operated by the insertion of the bracket lamp.

495,941. Electric Motor or Generator; Wm. Koedding, St. Louis, Mo. Application filed Sept. 21, 1891. In an electric motor or generator, the combination of two armatures, each having a zigzag magnetic circuit formed with transverse bars, said bars being wound in two or more coils, with one commutator between the armatures, said coil being connected with different bars of the commutator.

495,951. Incandescent Electric Lamp Holder; Leroy C. Whitney, Jr., Milwaukee, Wis. Application filed Dec. 10, 1892. A holder for incandescent electric lamps formed from a single piece of wire bent so as to form oppositely disposed loops for engagement with opposite sides of a lamp socket, and an obliquely extending arm provided at its free end with a hook adapted for engagement with the lamp cord.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886 - can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.